User Guide

Anritsu PowerXpert™ and USB Power Sensors

MA24104A, Inline High Power Sensor, 600 MHz to 4 GHz
MA24105A, Inline Peak Power Sensor, 350 MHz to 4 GHz
MA24106A, True-RMS Power Sensor, 10 MHz to 6 GHz
MA24108A, True-RMS Power Sensor, 10 MHz to 8 GHz
MA24118A, True-RMS Power Sensor, 10 MHz to 18 GHz
MA24126A, True-RMS Power Sensor, 10 MHz to 26 GHz

Anritsu Company
490 Jarvis Drive
Morgan Hill, CA 95037-2809
USA

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部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 [Cr(VI)]	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷线路板 (PCA)	×	○	×	×	○	○
机壳、支架 (Chassis)	×	○	×	×	○	○
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部件名称	有毒有害物质或元素					
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印刷线路板 (PCA)	×	○	×	×	○	○
机壳、支架 (Chassis)	×	○	×	×	○	○
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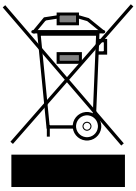

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Manufacturer's Name: ANRITSU COMPANY

Manufacturer's Address: Microwave Measurements Division
490 Jarvis Drive
Morgan Hill, CA 95037-2809
USA

declares that the product specified below:

Product Name: Inline High Power Sensor

Model Number: MA24104A

conforms to the requirement of:

EMC Directive:	2004/108/EC
Low Voltage Directive:	2006/95/EC

Electromagnetic Compatibility: EN61326:2006

Emissions:	EN55011: 2007 Group 1 Class A	
Immunity:	EN 61000-4-2:1995 +A1:1998 +A2:2001	4kV CD, 8kV AD
	EN 61000-4-3:2006 +A1:2008	3V/m
	EN 61000-4-4:2004	0 5kV SL, 1kV PL
	EN 61000-4-5:2006	0 5kV L-L, 1kV L-E
	EN 61000-4-6: 2007	3V
	EN 61000-4-11: 2004	100% @ 20msec

Electrical Safety Requirement:

Product Safety: EN 61010-1:2001

for Eric McLean

Eric McLean, Corporate Quality Director

Morgan Hill, CA

05 October 2009
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close, Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)

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Product Name: Inline Peak Power Sensor

Model Number: MA24105A

conforms to the requirement of:

EMC Directive:	2004/108/EC
Low Voltage Directive:	2006/95/EC

Electromagnetic Compatibility: EN61326:2006

Emissions:	EN55011: 2007 Group 1 Class A	
Immunity:	EN 61000-4-2:1995 +A1:1998 +A2:2001	4 kV CD, 8 kV AD
	EN 61000-4-3:2006 +A1:2008	3 V/m
	EN 61000-4-4:2004	0.5 kV S-L, 1 kV P-L
	EN 61000-4-5:2006	0.5 kV L-L, 1 kV L-E
	EN 61000-4-6: 2007	3 V
	EN 61000-4-11: 2004	100% @ 20 ms

Electrical Safety Requirement:

Product Safety: EN 61010-1:2001

Eric McLean, Corporate Quality Director

Morgan Hill, CA

27 Sept 2011
Date

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Manufacturer's Name: ANRITSU COMPANY

Manufacturer's Address: Microwave Measurements Division
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USA

declares that the product specified below:

Product Name: USB Power Sensor

Model Number: MA24106A

conforms to the requirement of:

EMC Directive 89/336/EEC as amended by Council Directive 92/31/EEC & 93/68/EEC
Low Voltage Directive 2006/95/EC as amended by Council directive 93/68/EEC

Electromagnetic Interference: EN61326:1997 +A1: 1998 +A2:2002 A3:2003

Emissions:	EN55011: 1998 +A1: 1999 +A2:2002 Group 1 Class A	
Immunity:	EN 61000-4-2:1995 +A1:1998 +A2:2001	- 4kV CD, 8kV AD
	EN 61000-4-3:2002 +A1:2002	- 10V/m
	EN 61000-4-4:2004	- N/A, I/O < 3 meters
	EN 61000-4-5:1995 +A1:2001	- N/A, I/O < 3 meters
	EN 61000-4-6:1996 +A1:2001	- N/A, I/O < 3 meters
	EN 61000-4-11:1994 +A1:2001	- N/A

Electrical Safety Requirement:

Product Safety: N/A

Eric McLean, Corporate Quality Director

Morgan Hill, CA

21 MAR 2007
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close, Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)

DECLARATION OF CONFORMITY

Manufacturer's Name: ANRITSU COMPANY

Manufacturer's Address: Microwave Measurements Division
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Morgan Hill, CA 95037-2809
USA

declares that the product specified below:

Product Name: USB Power Sensor

Model Number: MA24108A, MA24118A

conforms to the requirement of:

EMC Directive:	2004/108/EC
Low Voltage Directive:	2006/95/EC

Electromagnetic Compatibility: EN61326:2006

Emissions:	EN55011: 2007 Group 1 Class A	
Immunity:	EN 61000-4-2:1995 +A1:1998 +A2:2001	4kV CD, 8kV AD
	EN 61000-4-3:2006 +A1:2008	3V/m
	EN 61000-4-4:2004	0.5kV SL, 1kV PL
	EN 61000-4-5:2006	0.5kV L-L, 1kV L-E
	EN 61000-4-6: 2007	3V
	EN 61000-4-11: 2004	100% @ 20msec

Electrical Safety Requirement:

Product Safety: EN 61010-1:2001

Eric McLean, Corporate Quality Director

Morgan Hill, CA

28 APRIL 2009
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close, Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)

DECLARATION OF CONFORMITY

Manufacturer's Name: ANRITSU COMPANY

Manufacturer's Address: Microwave Measurements Division
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declares that the product specified below:

Product Name: USB Power Sensor

Model Number: MA24126A

conforms to the requirement of:

EMC Directive:	2004/108/EC
Low Voltage Directive:	2006/95/EC

Electromagnetic Compatibility: EN61326:2006

Emissions:	EN55011: 2007 Group 1 Class A	
Immunity:	EN 61000-4-2:1995 +A1:1998 +A2:2001	4kV CD, 8kV AD
	EN 61000-4-3:2006 +A1:2008	3V/m
	EN 61000-4-4:2004	0 5kV SL, 1kV PL
	EN 61000-4-5:2006	0 5kV L-L, 1kV L-E
	EN 61000-4-6: 2007	3V
	EN 61000-4-11: 2004	100% @ 20msec

Electrical Safety Requirement:

Product Safety: EN 61010-1:2001

for Eric McLean

Eric McLean, Corporate Quality Director

Morgan Hill, CA

05 October 2009
Date

European Contact: For Anritsu product EMC & LVD information, contact Anritsu LTD, Rutherford Close, Stevenage Herts, SG1 2EF UK, (FAX 44-1438-740202)

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CE

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N274

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Company uses the following symbols to indicate safety-related information. For your own safety, please read the information carefully *before* operating the equipment.

Symbols Used in Manuals

Danger

This indicates a risk from a very dangerous condition or procedure that could result in serious injury or death and possible loss related to equipment malfunction. Follow all precautions and procedures to minimize this risk.

Warning

This indicates a risk from a hazardous condition or procedure that could result in light-to-severe injury or loss related to equipment malfunction. Follow all precautions and procedures to minimize this risk.

Caution

This indicates a risk from a hazardous procedure that could result in loss related to equipment malfunction. Follow all precautions and procedures to minimize this risk.

Safety Symbols Used on Equipment and in Manuals

The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions *before* operating the equipment. Some or all of the following five symbols may or may not be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.

This indicates a compulsory safety precaution. The required operation is indicated symbolically in or near the circle.

This indicates a warning or caution. The contents are indicated symbolically in or near the triangle.

This indicates a note. The contents are described in the box.

These indicate that the marked part should be recycled.

For Safety

Warning

Always refer to the operation manual when working near locations at which the alert mark, shown on the left, is attached. If the operation, etc., is performed without heeding the advice in the operation manual, there is a risk of personal injury. In addition, the equipment performance may be reduced.

Moreover, this alert mark is sometimes used with other marks and descriptions indicating other dangers.

Warning

This equipment cannot be repaired by the operator. Do not attempt to remove the equipment covers or to disassemble internal components. Only qualified service technicians with a knowledge of electrical fire and shock hazards should service this equipment. There is a risk of damage to precision components.

Caution

Electrostatic Discharge (ESD) can damage the highly sensitive circuits in the instrument. ESD is most likely to occur as test devices are being connected to, or disconnected from, the instrument's front and rear panel ports and connectors. You can protect the instrument and test devices by wearing a static-discharge wristband. Alternatively, you can ground yourself to discharge any static charge by touching the outer chassis of the grounded instrument before touching the instrument's front and rear panel ports and connectors. Avoid touching the test port center conductors unless you are properly grounded and have eliminated the possibility of static discharge.

Repair of damage that is found to be caused by electrostatic discharge is not covered under warranty.

Table of Contents

Chapter 1—General Information

1-3 Description 1-1

1-4 CD-ROM Contents 1-1

PowerXpert Installation Program 1-1

Microsoft® .NET Framework Version 2.0 Installation Program 1-1

User Guide 1-1

Product Brochures 1-2

Measurement Uncertainty Calculator 1-2

Sample Visual Basic Program Folder 1-2

1-5 Initial Inspection 1-2

1-6 Sensor Identification 1-3

Customer Asset Tag Placement 1-3

1-7 Preparation for Storage/Shipment 1-4

1-8 Contacting Anritsu 1-4

Chapter 2—Installation (PC Only)

2-2 Hardware and Software Requirements 2-1

2-3 PowerXpert Application and Power Sensor Drivers 2-1

Installing PowerXpert 2-2

Installing Power Sensor Drivers 2-5

Chapter 3—Using PowerXpert™

3-2 PowerXpert Settings 3-2

3-3 PowerXpert™ Overview 3-4

Numerical Display Area 3-6

Sensor Information Area 3-6

Graticule Settings and Graphical Display Area 3-7

3-4 Continuous Mode 3-10

Duty Cycle 3-10

Relative 3-10

Units 3-10

Forward Measurement 3-11

Reverse Measurement 3-11

Video Bandwidth 3-11

Aperture Time 3-11

Measurement Hold 3-12

Apply Above Settings Button 3-12

3-5 Time Slot Mode 3-12

Number of Slots 3-12

Slot Width 3-13

Start and End Exclusion 3-13

Apply Above Settings Button 3-13

Table of Contents (Continued)

3-6 Scope Mode 3-13
Capture Time 3-13
Data Points 3-14
Gate and Fence 3-16
Apply Above Settings Button 3-17
3-7 General Settings 3-17
Zero Sensor 3-17
Frequency 3-17
Auto Average 3-18
Auto Averaging Source 3-18
Averaging Method 3-18
Averages 3-19
Offset 3-19
Range 3-19
Apply Above Settings Button 3-19
3-8 Trigger Settings 3-20
Trigger Source 3-20
Trigger Arm Type 3-20
Trigger Level 3-21
Trigger Edge 3-21
Trigger Delay 3-21
Noise Immunity 3-22
Arm Trigger Button 3-22
3-9 Tools 3-23
Zero All Sensors 3-23
Capture Screen 3-23
Log Data 3-24
Multiple Sensor Display 3-25
View Summary 3-26
Offset Table 3-27
Updating the Firmware 3-27
3-10 Settings 3-28
Saving and Recalling Settings 3-28
Resetting to Factory Settings 3-28
Sensor Time Out Setting 3-28
Secure Mode 3-30
3-11 Help 3-31

Chapter 4—Power Sensor Care

4-2 Power Sensor Precautions 4-1
4-3 RF Connector Precautions 4-2
4-4 Connection Techniques 4-3
Connection Procedure 4-3
Disconnection Procedure 4-3
4-5 RF Connector Preventive Care 4-4
Visual Inspection 4-4
Pin Depth Measurement 4-4
Pin Depth Dimensions 4-5
Pin Depth Gauge 4-6
Pin Depth Tolerances 4-6
4-6 Connector Cleaning 4-7
Required Cleaning Items 4-7
Important Cleaning Tips 4-7
Cleaning Procedure 4-7

Chapter 5—Using the MA24104A

5-1 Sensor Overview 5-1
5-2 Making Measurements 5-1
Basic Power Measurement 5-2
Connecting the Sensor 5-3
Zeroing the Sensor 5-4
Calibrating the Sensor 5-4
Applying a Calibration Factor Correction 5-4
Optimizing the Readings 5-4
5-3 Measurement Considerations 5-6
Time Varying Signals 5-6
Multitone Signals 5-6
Noise and Averaging 5-6
Settling Time 5-7
Maximum Power 5-7
5-4 Uncertainty of a Measurement 5-8
Measurement Uncertainty Calculator 5-8
Uncertainty Components 5-8
Uncertainty Examples 5-9
5-5 Error States 5-10

Chapter 6—Operational Testing for the MA24104A

6-2 Precautions 6-1
6-3 Required Equipment - MA24104A 6-2
6-4 VSWR Pretest 6-3
6-5 Directivity Test 6-4
6-6 Frequency Response Test 6-6
6-7 Linearity Test 6-8

Chapter 7—Using the MA24105A

7-1 Sensor Overview 7-1
7-2 Making Measurements 7-2
Basic Power Measurement 7-2
Connecting the Sensor 7-4
Zeroing the Sensor 7-4
Calibrating the Sensor 7-4
Applying a Calibration Factor Correction 7-4
Optimizing the Readings 7-4
7-3 Measurement Considerations 7-6
Multitone Signals 7-6
Noise and Averaging 7-6
Settling Time 7-6
Maximum Power 7-6
7-4 Uncertainty of a Measurement 7-8
Measurement Uncertainty Calculator 7-8
Uncertainty Examples 7-9
7-5 Error States 7-10

Chapter 8—Operational Testing for the MA24105A

8-2 Precautions 8-1
8-3 Required Equipment - MA24105A 8-2
8-4 VSWR Pretest 8-3
8-5 Directivity Test 8-4
8-6 Frequency Response Test 8-7
8-7 Linearity Test 8-9

Chapter 9—Using the MA24106A

9-1 Sensor Overview 9-1
9-2 Making Measurements 9-1
Basic Power Measurement 9-1
Connecting the DUT 9-2
Zeroing the Sensor 9-3
Calibrating the Sensor 9-3
Applying a Calibration Factor Correction 9-3
Optimizing the Readings 9-3

9-3 Measurement Considerations . . . 9-5
Time Varying Signals . . . 9-5
High Crest Factor Signals (peak to average ratio) . . . 9-5
Multitone Signals . . . 9-6
Noise and Averaging . . . 9-6
Settling Time . . . 9-7
9-4 Uncertainty of a Measurement . . . 9-7
Measurement Uncertainty Calculator . . . 9-7
Uncertainty Example . . . 9-8
9-5 Error States . . . 9-9

Chapter 10—Operational Testing for the MA24106A

10-2 Precautions . . . 10-1
10-3 Required Equipment - MA24106A . . . 10-2
10-4 VSWR Pretest . . . 10-3
10-5 Frequency Response Test . . . 10-4
10-6 Linearity Test . . . 10-6

Chapter 11—Using the MA24108A, MA24118A, and MA24126A

11-1 Sensor Overview . . . 11-1
11-2 Making Measurements . . . 11-1
Basic Power Measurement . . . 11-1
Connecting the DUT . . . 11-2
Zeroing the Sensor . . . 11-2
Calibrating the Sensor . . . 11-3
Applying a Calibration Factor Correction . . . 11-3
Optimizing the Readings . . . 11-3
11-3 Measurement Considerations . . . 11-5
High Crest Factor Signals (peak to average ratio) . . . 11-5
Multitone Signals . . . 11-5
Noise and Averaging . . . 11-6
Average Value of Time Varying Signals . . . 11-6
Settling Time . . . 11-6
Noise and Time Resolution in Scope Mode . . . 11-7
Optimizing Internal Triggering . . . 11-7
Noise Floor in Scope Mode . . . 11-7
11-4 Uncertainty of a Measurement . . . 11-8
Measurement Uncertainty Calculator . . . 11-8
Uncertainty Examples . . . 11-9
11-5 Error States . . . 11-11

Chapter 12—Operational Testing for the MA24108A, MA24118A, and MA24126A

12-2 Precautions 12-1
12-3 Required Equipment - MA24108A/118A/126A 12-2
12-4 VSWR Pretest 12-3
12-5 Frequency Response Test 12-4
12-6 Linearity Test 12-7

Chapter 13—Remote Operation

13-2 Programming the Sensor 13-1
Send and Receive Format 13-1
HyperTerminal 13-1
Time Resolution 13-2
Sampling Rate 13-2
Error Responses 13-2
Default Sensor Settings 13-2
13-3 General Purpose Commands 13-4
13-4 Mode Commands 13-18
Continuous Average Mode (CA Mode) 13-19
Slot Mode 13-19
Scope Mode 13-21
13-5 Trigger Commands 13-24
Trigger Source 13-24
Trigger Level 13-26
Trigger Edge 13-26
Trigger Delay 13-27
Trigger Noise Immunity 13-28
Trigger Arming 13-29

Appendix A—Sample Visual Basic Code

A-2 Using the Demo Application A-1

Appendix B—Upgrading the Firmware

B-2 MA24104A, and MA24106A Firmware Upgrade B-1
B-3 MA24105A, MA24108A, MA24118A, and MA24126A Firmware Upgrade B-5
Removing Old Upgrade Driver B-7

Appendix C—USB/Serial Port Compatibility

C-2 Method 1–Download Updated Software C-2

Index

Alphabetical Index of Programming Commands

Chapter 1 — General Information

1-1 Scope of Manual

This manual provides general information, installation, and operating information for the Anritsu MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, and MA24126A USB Power Sensors and the Anritsu PowerXpert™ application. Throughout this manual, the terms MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A, and power sensor are used interchangeably to refer to the device. Manual organization is shown in the table of contents.

1-2 Introduction

This chapter contains general information about the Anritsu USB power sensors. It includes a general description of the device and information on its identification number, information on initial inspection, and preparation for storage and shipment.

1-3 Description

The Anritsu USB power sensors are highly accurate, standalone instruments that communicate with a PC via USB. The power sensors also communicate with many Anritsu handheld instruments such as Spectrum Master, BTS Master, VNA Master, Cell Master, and Site Master (Option 19 required in these instruments). The sensors are ideal for measuring the average power of CW or modulated RF waveforms such as 3G, 4G, OFDM, and multitone signals. In other words, they measure true-RMS power regardless of the type of input signal.

Note	The MA24104A and MA24106A have a USB 2.0 interface with a USB Type Mini-B port. The MA24105A, MA24108A, MA24118A, and MA24126A have a USB 2.0 interface with a USB Type Micro-B port. These interfaces are USB 2.0 compatible, but with an interface speed of 12 Mbps, and they also supply power to the sensors. The power sensors can be remotely programmed over this USB interface.

1-4 CD-ROM Contents

The PowerXpert CD-ROM contains the following programs, documents and accessories, all of which are accessible from the CD-ROM startup page (startup.htm):

PowerXpert Installation Program

Provides the user interface to the power sensor via USB connection to a PC.

Microsoft® .NET Framework Version 2.0 Installation Program

Available for installation if .NET Framework does not already exist on your PC. The PowerXpert installation program will detect whether or not this is already on your PC and will provide a message if it is not installed.

User Guide

The User Guide contains instructions for installation, operation and operational testing for all the USB power sensors and the PowerXpert application.

Product Brochures

Links to product brochures provide complete operational specifications and features for your power sensor.

Measurement Uncertainty Calculator

A Microsoft Excel tool for calculating power uncertainty is provided. It contains two tabs; one that provides measurement uncertainty for each sensor (selectable from a drop-down menu), and another tab that provides additional uncertainty components and calculated values for the MA24105A Peak Power Sensor.

Sample Visual Basic Program Folder

Provides a link to a folder containing a sample application (DemoApp.exe) written in Microsoft Visual Basic® 6.0. This application and its code are provided as an example so the user can develop custom applications for use with the power sensor. Instructions for use, and the code for DemoApp is included in Appendix A.

1-5 Initial Inspection

Inspect the shipping container for damage. If the shipping container is damaged, retain it until the contents of the shipment have been checked against the packing list and the power sensor has been checked for mechanical and electrical operation. The following items are included with every shipment:

MA24104A:

- MA24104A, Inline High Power Sensor
- 2300-526, Installation CD
- Quick Start Guide
- 2000-1566-R, USB 2.0A to Mini-B Cable
- 800-441, RS232 Cable
- 40-168-R, External Power Supply
- 69747, AA Alkaline Batteries (qty 3)

MA24105A:

- MA24105A, Inline Peak Power Sensor
- 2300-526, Installation CD
- Quick Start Guide
- 2000-1606-R, 1.8 meter USB A to Micro-B Cable with Latch

MA24106A:

- MA24106A, USB Power Sensor
- 2300-526, Installation CD
- Quick Start Guide
- 2000-1566-R, USB 2.0 A to Mini-B Cable

MA24108A, MA24118A, and MA24126A:

- MA24108A, MA24118A, or MA24126A USB Power Sensor
- 2300-526, Installation CD
- Quick Start Guide
- 2000-1606-R, 1.8 meter USB A to Micro-B Cable with Latch
- 2000-1605-R, 1.5 meter BNC(M) to MCX(M) Cable

If the shipment is incomplete or if the power sensor is damaged mechanically or electrically, notify your local sales representative or Anritsu Customer Service. If the shipping container is damaged or shows signs of stress, notify the carrier as well as Anritsu. Keep the shipping materials for the carrier's inspection.

1-6 Sensor Identification

All Anritsu power sensors are assigned a unique seven digit serial number, such as “0701012”. The serial number is printed on a label that is affixed to the unit. When ordering parts or corresponding with Anritsu Customer Service, please use the correct serial number with reference to the specific instrument's model number (for example, model MA24126A power sensor, serial number: 0701012).

Customer Asset Tag Placement

When affixing an asset tag to the power sensors, please use an area on the cover plate as indicated below to ensure that the asset tag is retained with the product during service.

Figure 1-1. Customer Asset Tag Placement

1-7 Preparation for Storage/Shipment

Preparing the power sensor for storage consists of cleaning the unit, packing the inside with moisture-absorbing desiccant crystals, and storing the unit in the recommended temperature environment. Please refer to the data sheet for storage temperature recommendations.

To provide maximum protection against damage in transit, the power sensor should be repackaged in the original shipping container. If this container is no longer available and the unit is being returned to Anritsu for repair, please advise Anritsu Customer Service; they will send a new shipping container free of charge. In the event neither of these two options is possible, instructions for packaging and shipment are given below:

Note	Disconnect any USB and Trigger cables before packaging the power sensor.

- **Use a Suitable Container:** Obtain a corrugated cardboard carton. This carton should have inside dimensions of no less than 15 cm larger than the unit dimensions to allow for cushioning.
- **Protect the Instrument:** Surround the unit with polyethylene sheeting to protect the finish.
- **Cushion the Instrument:** Cushion the instrument on all sides by tightly packing urethane foam between the carton and the unit. Provide at least three inches of dunnage on all sides.
- **Seal the Container:** Seal the carton by using either shipping tape or an industrial stapler.
- **Address the Container:** If the instrument is being returned to Anritsu for service, mark the address of the appropriate Anritsu service center and your return address on the carton in one or more prominent locations.

1-8 Contacting Anritsu

To contact Anritsu, please visit:

http://www.anritsu.com/contact.asp

From here, you can select the latest sales, service and support contact information in your country or region, provide online feedback, complete a “Talk to Anritsu” form to get your questions answered, or obtain other services offered by Anritsu.

1-9 Product Update Information

Updated product information can be found via the Anritsu Power Meters and Sensors product page:

The URL to this page is:

http://www.anritsu.com/en-US/Products-Solutions/Test-Measurement/RF-Microwave/Power-Meters-and-Sensors/index.aspx

Selecting your product model from the product page will lead you to a Library tab that contains links to all of the latest documentation and downloads related to your Anritsu product.

Chapter 2 — Installation (PC Only)

2-1 Introduction

This chapter provides information on installing the Anritsu PowerXpert™ application and the MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, or MA24126A power sensor drivers. It contains the following:

- "Hardware and Software Requirements" for the Anritsu PowerXpert Application
- "Installing PowerXpert" procedure
- "Installing Power Sensor Drivers" procedure

2-2 Hardware and Software Requirements

Please make sure that the following minimum requirements are met for installing and using the software:

- Intel® Pentium® III with 1 GB RAM or Intel® Pentium® IV with 512 MB RAM, or equivalent (Intel® Pentium® IV with 1 GB RAM recommended; a dual core processor with 2 GB RAM is recommended for use with the multisensor feature.)
- All versions of Microsoft® Windows 7 and Windows Vista®, Windows XP or Windows 2000
- 100 MB hard-disk free space
- Display resolution 1024 × 768
- USB 2.0 full speed (compatible with USB 1.0 and 1.1) interface
- CD-ROM drive

2-3 PowerXpert Application and Power Sensor Drivers

Both the PowerXpert application and power sensor drivers must be installed before using the power sensor. Follow the steps below as a guide for proper installation.

Note	Earlier versions of PowerXpert **and** the ATMEL SAM-BA software must first be uninstalled from the PC before installing PowerXpert.
	Earlier versions of the MA24108A, MA24118A, or MA24126A power sensors must be upgraded with firmware version 2.0 or later to use all of the features of PowerXpert (firmware must be upgraded using PowerXpert). Refer to Appendix B, "Upgrading the Firmware" for information about upgrading the power sensor firmware.

Installing PowerXpert

1. Insert the installation CD in the drive of your computer. If the menu does not open automatically, open the file named Startup.htm located on the CD.

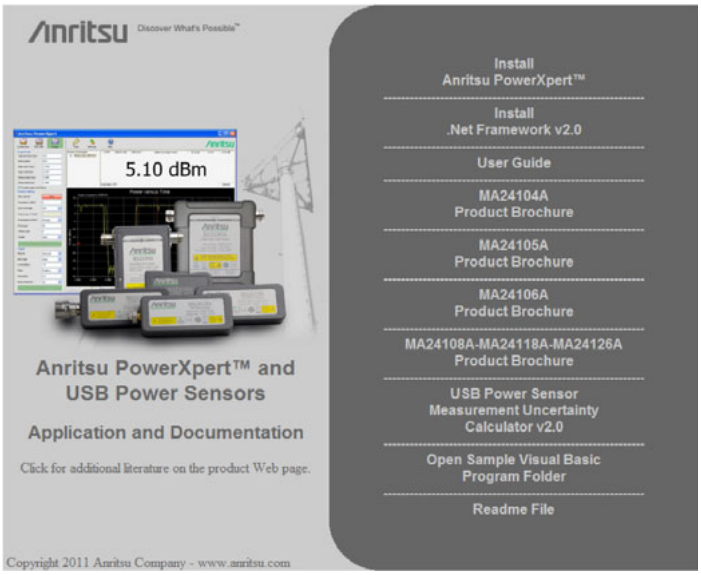


Figure 2-1. Anritsu PowerXpert CD Menu

2. Click **Install Anritsu PowerXpert™** and select **Run** to start the installation.

Note	The PowerXpert application installation will halt if the Microsoft® .Net Framework version 2.0 is not installed. If required, please install this from the menu.

3. Click **Next** in the following screen to begin the installation process.

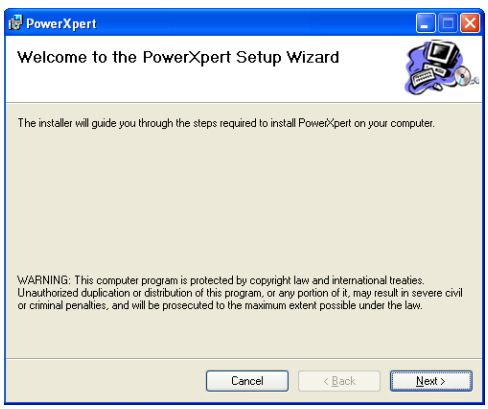

PowerXpert
Welcome to the PowerXpert Setup Wizard
The installer will guide you through the steps required to install PowerXpert on your computer.
WARNING: This computer program is protected by copyright law and international treaties. Unauthorized duplication or distribution of this program, or any portion of it, may result in severe civil or criminal penalties, and will be prosecuted to the maximum extent possible under the law.
Cancel
< Back
Next >

Figure 2-2. Installing Anritsu PowerXpert Application

4. Read the license agreement and select "I Agree" to continue, then click **Next**.

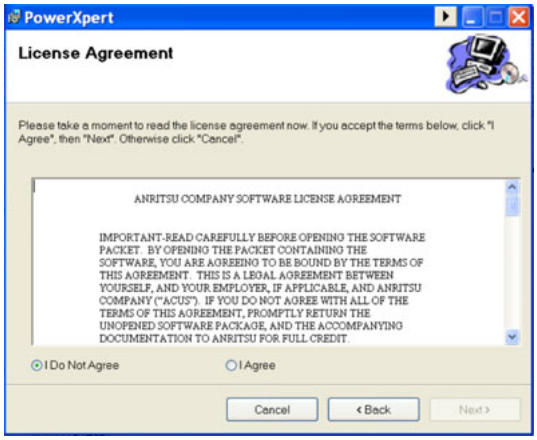

PowerXpert
License Agreement
Please take a moment to read the license agreement now. If you accept the terms below, click "I Agree", then "Next". Otherwise click "Cancel".
ANRITSU COMPANY SOFTWARE LICENSE AGREEMENT
IMPORTANT-READ CAREFULLY BEFORE OPENING THE SOFTWARE PACKET. BY OPENING THE PACKET CONTAINING THE SOFTWARE, YOU ARE AGREEING TO BE BOUND BY THE TERMS OF THIS AGREEMENT. THIS IS A LEGAL AGREEMENT BETWEEN YOURSELF, AND YOUR EMPLOYER, IF APPLICABLE, AND ANRITSU COMPANY ("ACUS"). IF YOU DO NOT AGREE WITH ALL OF THE TERMS OF THIS AGREEMENT, PROMPTLY RETURN THE UNOPENED SOFTWARE PACKAGE, AND THE ACCOMPANYING DOCUMENTATION TO ANRITSU FOR FULL CREDIT.
I Do Not Agree
I Agree
Cancel
< Back
Next >

Figure 2-3. PowerXpert License

5. Browse for the installation folder, then click **Next**. The default installation directory is: C:\Program Files\Anritsu\PowerXpert

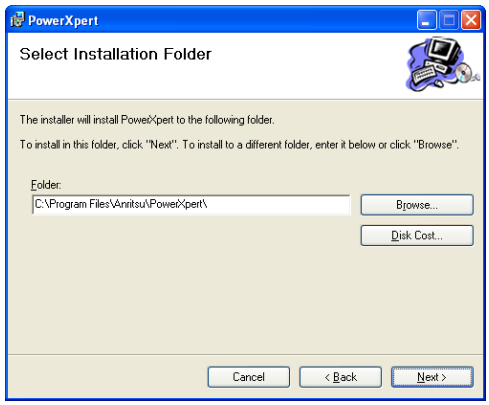

PowerXpert
Select Installation Folder
The installer will install PowerXpert to the following folder.
To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".
Folder:
C:\Program Files\Anritsu\PowerXpert\
Browse...
Disk Cost...
Cancel
< Back
Next >

Figure 2-4. Installing Anritsu PowerXpert Application

6. Select **Next** to continue with the software installation.

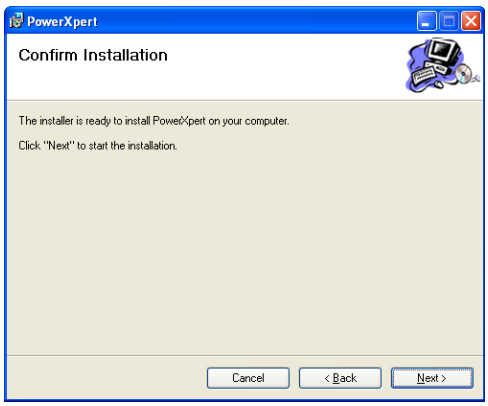

PowerXpert
Confirm Installation
The installer is ready to install PowerXpert on your computer.
Click "Next" to start the installation.
Cancel
< Back
Next >

Figure 2-5. Installing Anritsu PowerXpert Application

The software installs to the selected location.

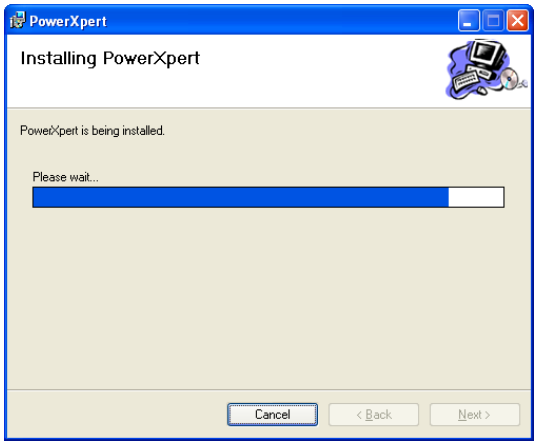


Figure 2-6. Anritsu PowerXpert Installation

7. When the installation completes, click **Close**.

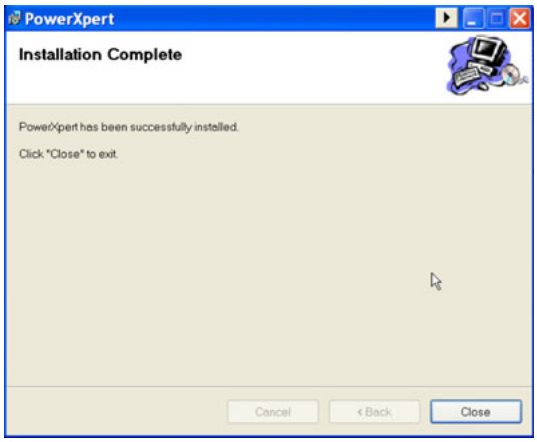


Figure 2-7. Installing Anritsu PowerXpert Application

Note	Running PowerXpert in **Windows Vista:** The application must be run as administrator because of strict Vista security policies. Running PowerXpert in **Windows 7:** After installing PowerXpert, right click the application icon, select the compatibility tab under the Properties option, and then set the application to run in compatibility mode for Windows XP service pack 3 (Figure 2-8). The application must be run as administrator because of strict Windows 7 security policies.

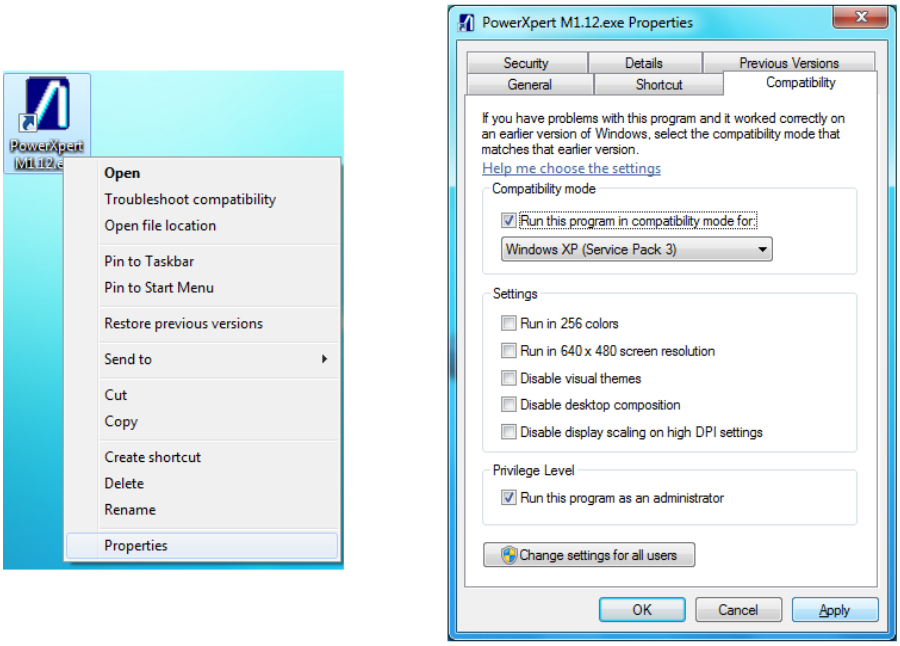


Figure 2-8. Setting PowerXpert to Run in Windows XP Compatibility Mode

The PowerXpert application can be launched from the Windows Start menu from the Anritsu program group.

If you are installing a new power sensor, continue to the next section, "Installing Power Sensor Drivers".

Installing Power Sensor Drivers

1. Connect the power sensor to the USB port of the PC with the supplied USB cable.
   The status LED lights green indicating that the sensor is turned ON.
2. When the Found New Hardware Wizard installation screen appears, select **No, not this time** to search for software, and then click **Next**.

Found New Hardware Wizard
Welcome to the Found New Hardware Wizard
Windows will search for current and updated software by looking on your computer, on the hardware installation CD, or on the Windows Update Web site (with your permission).
Read our privacy policy
Can Windows connect to Windows Update to search for software?
Yes, this time only
Yes, now and every time I connect a device
No, not this time
Click Next to continue.
< Back
Next >
Cancel

Figure 2-9. Found New Hardware Wizard

3. Select **Install the software automatically (Recommended)**, and then click **Next**.

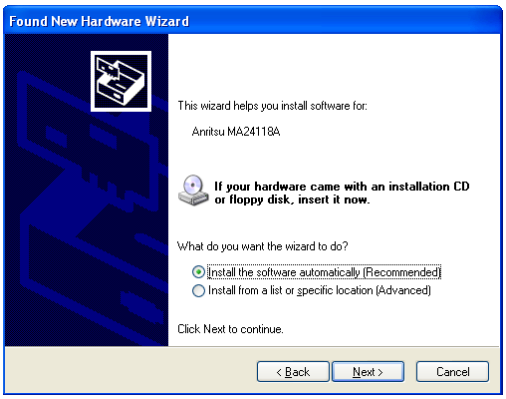

Found New Hardware Wizard
This wizard helps you install software for:
Anritsu MA24118A
If your hardware came with an installation CD or floppy disk, insert it now.
What do you want the wizard to do?
Install the software automatically (Recommended)
Install from a list or specific location (Advanced)
Click Next to continue.
< Back
Next >
Cancel

Figure 2-10. Found New Hardware Wizard

4. Select the sensor being installed from the list, then click **Next** as shown below.

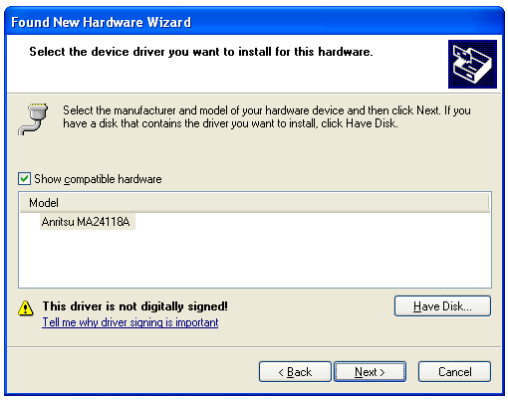

Found New Hardware Wizard
Select the device driver you want to install for this hardware.
Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.
Show compatible hardware
Model
Anritsu MA24118A
This driver is not digitally signed!
Tell me why driver signing is important
Have Disk...
< Back
Next >
Cancel

Figure 2-11. Found New Hardware Wizard

5. The Hardware Installation warning dialog appears as shown below. Click **Continue Anyway**.

Hardware Installation
The software you are installing for this hardware:
Anritsu MA24118A
has not passed Windows Logo testing to verify its compatibility with Windows XP. (Tell me why this testing is important.)
Continuing your installation of this software may impair or destabilize the correct operation of your system either immediately or in the future. Microsoft strongly recommends that you stop this installation now and contact the hardware vendor for software that has passed Windows Logo testing.
Continue Anyway
STOP Installation

Figure 2-12. Hardware Installation Warning

The hardware driver installs automatically.

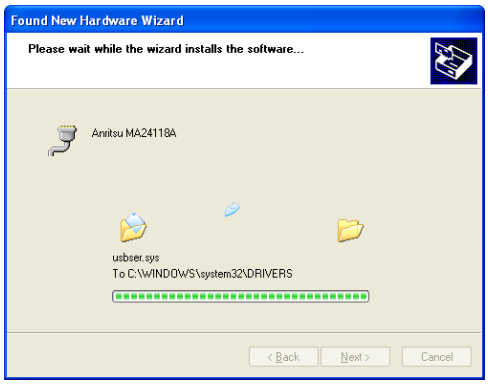


Figure 2-13. Found New Hardware Wizard

6. When the installation is complete, click **Finish** to close the wizard.

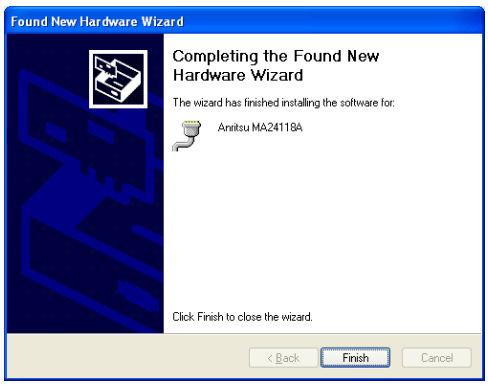


Figure 2-14. Found New Hardware Wizard

7. The power sensor is now ready for use. Launch the Anritsu PowerXpert application from the new desktop icon or from the **Start** | Programs | Anritsu menu. Refer to Chapter 3, "Using PowerXpert™" for information about using the Anritsu PowerXpert application.

Chapter 3 — Using PowerXpert™

3-1 Introduction

This chapter provides information and instructions on using the Anritsu PowerXpert™ application, a data analysis and control software for use with Anritsu's USB power sensors. PowerXpert provides a graphical user interface (GUI), making the PC appear like a traditional power meter that facilitates average power, time slot, and scope-like measurements. PowerXpert is capable of simultaneous operation of up to eight power sensors and, depending on which power sensors are connected to the PC, the PowerXpert application operates in three distinct modes as follows:

- "Continuous Mode" available with all power sensors
- "Time Slot Mode" available with the MA24108A, MA24118A, and MA24126A only
- "Scope Mode" available with the MA24108A, MA24118A, and MA24126A only

For information about using your power sensor, refer to one of the following Chapters for your power sensor:

- Chapter 5, "Using the MA24104A"
- Chapter 7, "Using the MA24105A"
- Chapter 9, "Using the MA24106A"
- Chapter 11, "Using the MA24108A, MA24118A, and MA24126A"

The power sensors are also compatible with the Option 19 enabled Site Master™, Cell Master™, Spectrum Master™, BTS Master™, VNA Master™, and the MS271xB Economy Microwave Spectrum Analyzer family of instruments. The power sensor easily connects to these instruments via a USB A to Mini-/Micro-B cable, turning them into a virtual power meter. Please refer to instrument-specific user guides for operation of the sensors.

3-2 PowerXpert Settings

PowerXpert always starts up in the default state of the connected sensor. Upon disconnection from PowerXpert, the power sensor resets and, after reconnection, restarts in the default state. Some features and settings offered by PowerXpert are only available with select power sensor models.

Table 3-1. PowerXpert Sensor Compatibility Table (1 of 2)

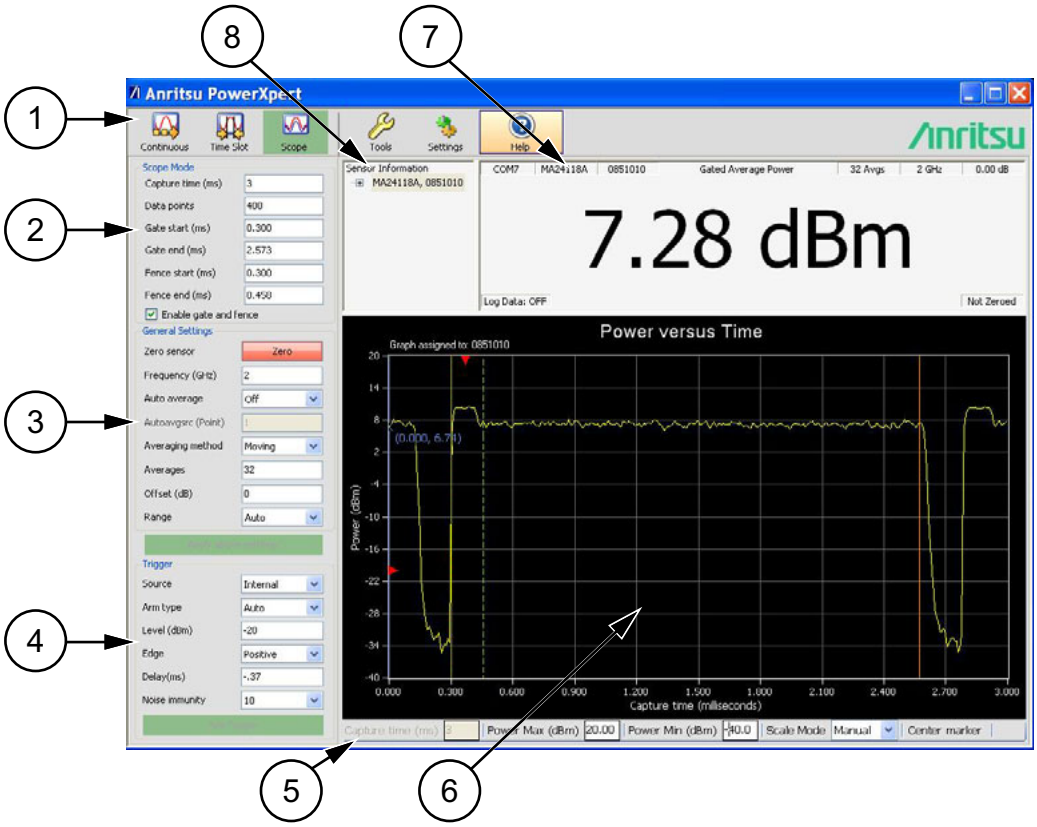
PowerXpert Features		USB Power Sensors					
		MA24104A	MA24105A	MA24106A	MA24108A	MA24118A	MA24126A
Continuous Mode	Duty Cycle	-	x	-	x	x	x
	Relative Mode	x	x	x	x	x	x
	Units	x	x	x	x	x	x
	Aperture time	x	-	x	x	x	x
	Forward Power	x	x	x	x	x	x
	Reverse Power	-	x	-	-	-	-
	Peak Power	-	x	-	-	-	-
	Crest Factor	-	x	-	-	-	-
	CCDF	-	x	-	-	-	-
	Burst Average	-	x	-	-	-	-
	Reflection Coeff	-	x	-	-	-	-
	Return-loss	-	x	-	-	-	-
	VSWR	-	x	-	-	-	-
	Video BW	-	x	-	-	-	-
	Measurement hold	x	-	x	x	x	x
Time Slot Mode	Number of slots	-	-	-	x	x	x
	Slot width	-	-	-	x	x	x
	Start exclusion	-	-	-	x	x	x
	End exclusion	-	-	-	x	x	x
Scope Mode	Capture time	-	-	-	x	x	x
	Data points	-	-	-	x	x	x
	Gate start	-	-	-	x	x	x
	Gate end	-	-	-	x	x	x
	Fence start	-	-	-	x	x	x
	Fence end	-	-	-	x	x	x
General Settings	Zero sensor	x	x	x	x	x	x
	Frequency	x	x	x	x	x	x
	Auto average	-	-	-	x	x	x
	Auto avgsrc	-	-	-	x	x	x
	Averaging method	-	-	-	x	x	x
	Averages	x	x	x	x	x	x
	Offset	x	x	x	x	x	x
	Range	-	x	-	x	x	x
Trigger	Source	-	-	-	x	x	x
	Arm Type	-	-	-	x	x	x
	Level	-	-	-	x	x	x
	Edge	-	-	-	x	x	x
	Delay	-	-	-	x	x	x
	Noise immunity	-	-	-	x	x	x

Table 3-1. PowerXpert Sensor Compatibility Table (2 of 2)

PowerXpert Features		USB Power Sensors					
		MA24104A	MA24105A	MA24106A	MA24108A	MA24118A	MA24126A
More Settings	Modulation Type	-	x	-	-	-	-
Tools	Zero all sensors	x	x	x	x	x	x
	Capture Screen	x	x	x	x	x	x
	Log data	x	x	x	x	x	x
	Multiple sensor display	x	x	x	x	x	x
	Offset table	x	-	x	-	-	-
	Update Firmware	x	x	x	x	x	x
	View Summary	-	x	-	-	-	-
Settings	Save/Recall setup	-	-	-	x	x	x
	Reset to factory settings	-	-	-	x	x	x
	Set sensor timeout	-	-	-	x	x	x
	Secure Mode	-	-	-	x	x	x

3-3 PowerXpert™ Overview

PowerXpert's graphical user interface layout is divided into eight sections as illustrated in Figure 3-1. Note that the screen for the MA24105A is shown in Figure 3-2. This numerical display is different in that it shows forward and reverse measurements.



Index	Description
1	The Anritsu PowerXpert Tool Bar selects one of the following three modes: "Continuous Mode" available with all power sensors "Time Slot Mode" available with the MA24108A, MA24118A, and MA24126A only "Scope Mode" available with the MA24108A, MA24118A, and MA24126A only The tool bar also provides access to: "Tools" to "Zero All Sensors", "Capture Screen", "Log Data", show the "Multiple Sensor Display", set up an "Offset Table", and for "Updating the Firmware" "Settings" for "Saving and Recalling Settings", "Resetting to Factory Settings", configuring the "Sensor Time Out Setting", and entering "Secure Mode" "Help"
2	Displays the selected "Continuous Mode", "Time Slot Mode", or "Scope Mode" Settings. The **Apply above settings** button must be clicked to apply any setting changes.
3	"General Settings" The **Apply above settings** button must be clicked to apply any setting changes.
4	"Trigger Settings" available with the MA24108A, MA24118A, and MA24126A only The **Arm trigger** button must be clicked to apply any setting changes.
5 and 6	"Graticule Settings and Graphical Display Area" Changes to these settings are applied by pressing the **Enter** key.

Figure 3-1. Anritsu PowerXpert Application GUI Overview (1 of 2)

7	"Numerical Display Area" (Note that the screen shown for MA24105A displays two values, forward and reverse).
8	Sensor Information Area showing sensor model and serial number, communications port, and firmware version.

Figure 3-1. Anritsu PowerXpert Application GUI Overview (2 of 2)

MA24105A GUI

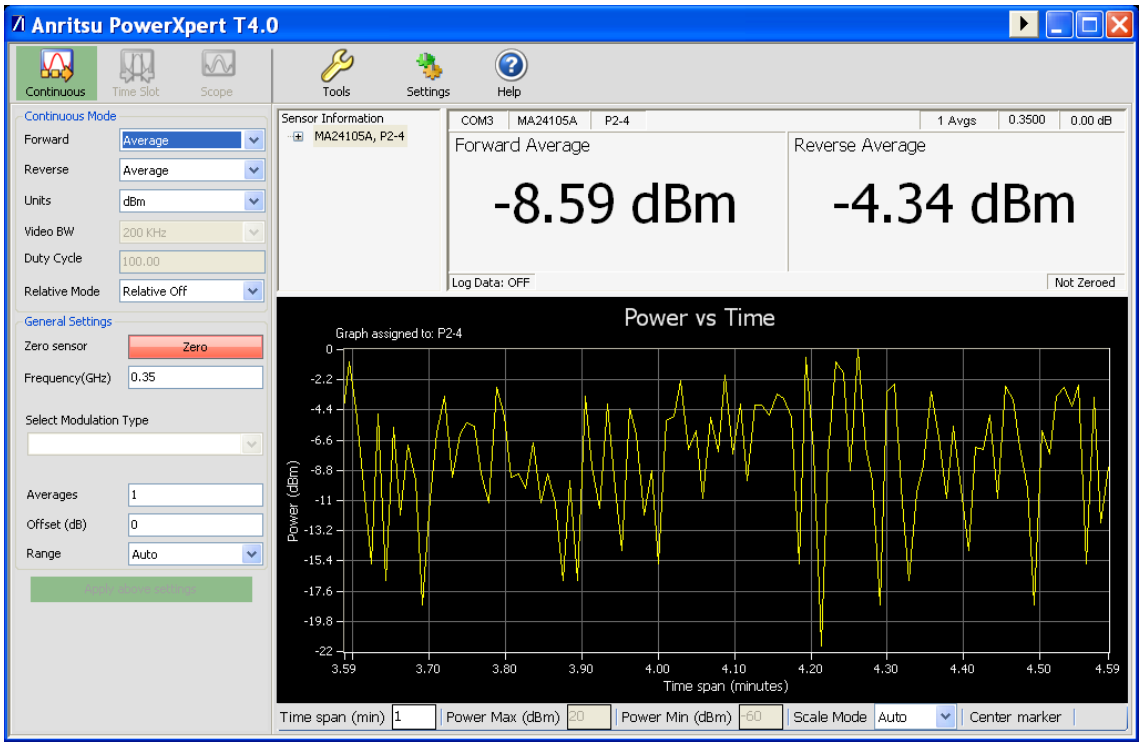


Figure 3-2. MA24105A GUI

Numerical Display Area

The display window contains the following information:

Index	Description
1	Communications port to which the sensor is connected
2	Model number of the connected power sensor
3	Serial number of the connected power sensor
4	Averaging count
5	Measurement frequency (Cal Factor)
6	Fixed offset value
7	Numerical reading with units of measure
8	Sensor Zero status
9	Data Logging status
10	Sensor error messages
11	Sensor status messages (displayed temporarily)

Figure 3-3. Anritsu PowerXpert Numerical Display Area

Sensor Information Area

When using multiple sensors, the sensor parameters and numerical and graphical displays are associated with the selected sensor in the Sensor Information area.

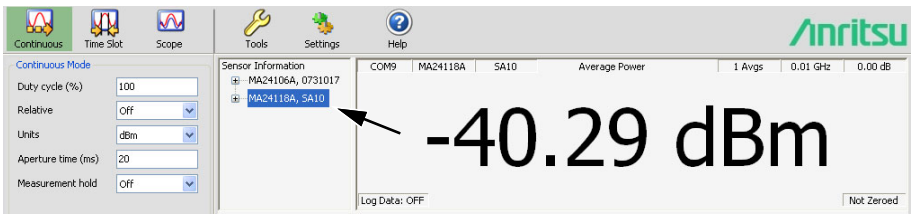
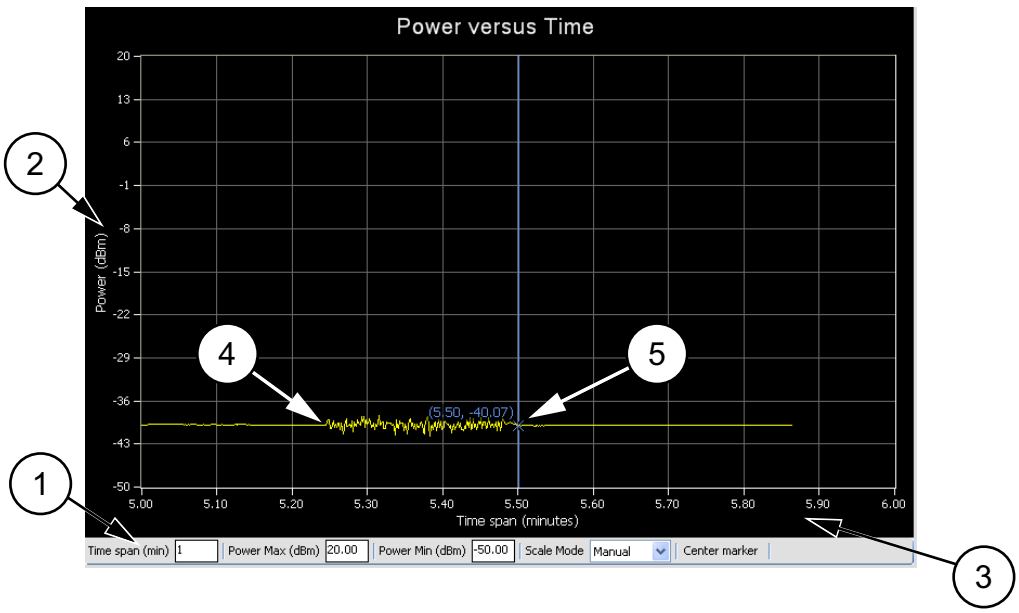


Figure 3-4. Selecting Sensor

Graticule Settings and Graphical Display Area

This section provides a brief overview of the graticule settings and graphical display areas that are presented in the different operating modes of PowerXpert. The Power versus Time graph is used in all modes and provides the ability to plot measured power with respect to time (or time slots). This feature can be used for drift testing, tuning circuits, and for monitoring circuit behaviors to external stimuli. The graph starts automatically and updates continuously in real time.

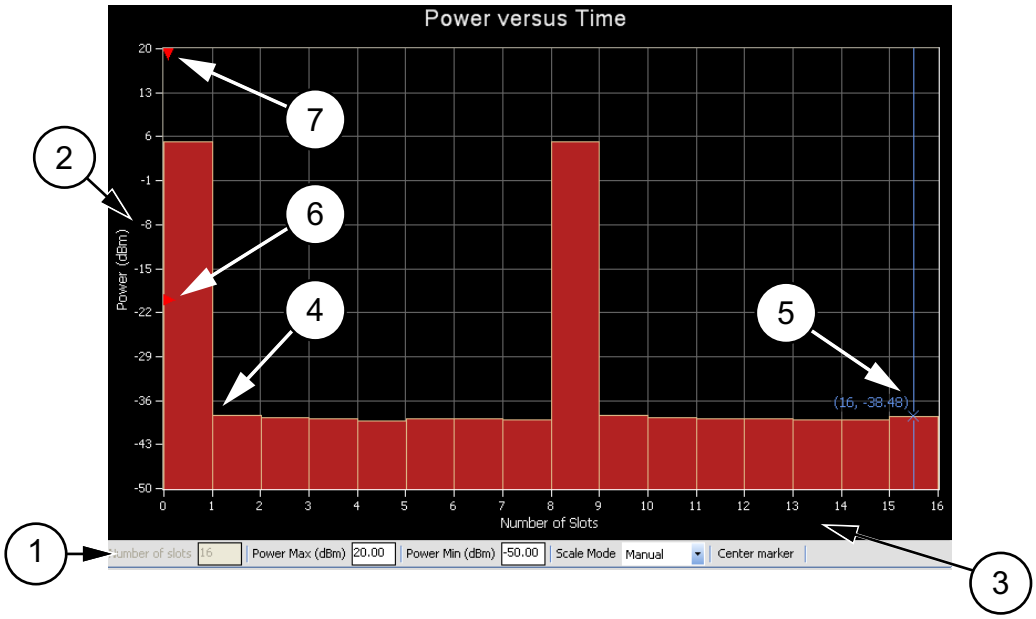
The following Power versus Time graph is used in "Continuous Mode":



Index	Description
1	Graticule settings area: **Time Span (min):** Sets the current time span setting from 0.1 minutes up to a maximum of 1440 minutes. **Power Max (dBm):** Sets the upper power level for the vertical scale. **Power Min (dBm):** Sets the lower power level for the vertical scale. **Scale Mode:** Sets the vertical scaling to Automatic or Manual (**Power Max (dBm)** and **Power Min (dBm)** settings are not available when set to Automatic). Changes to these settings are applied by pressing the **Enter** key.
2	The vertical scale displays the power level in dBm, regardless of the Units settings of dBm, µW, mW, or W from the "Continuous Mode" settings area.
3	The horizontal scale displays the time in minutes and may be increased or decreased from the graticule settings area. This scale increases up to a maximum of 1440 minutes.
4	Graphical trace display showing the power level as a function of time.
5	Marker showing as a vertical blue line with an x on the marker point and numerical values for the time (in minutes) and power level (in dBm). The marker is available for reading power at an instant of time. It can be dragged with the mouse and can be centered in the display via the **Center marker** button.

Figure 3-5. Anritsu PowerXpert Graphical Display Area (Continuous Average Mode)

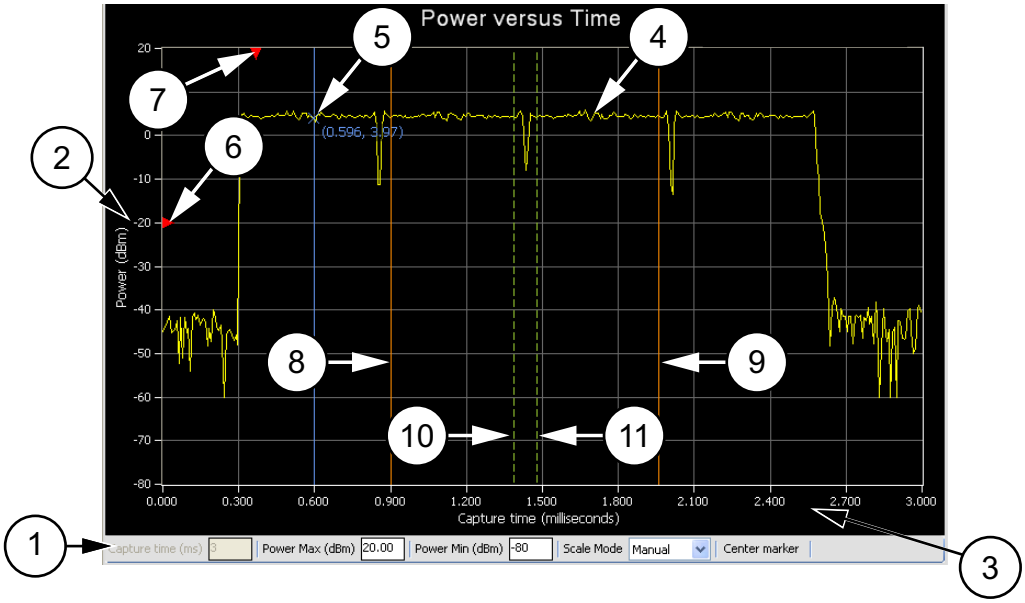
The following Power versus Time graph is used in "Time Slot Mode" and is available only with the MA24108A, MA24118A, and MA24126A power sensors.



Index	Description
1	Graticule Settings: **Number of Slots:** Displays the current number of slots setting. This setting is changed via the "Time Slot Mode" settings area. **Power Max (dBm):** Sets the upper power level for the vertical scale. **Power Min (dBm):** Sets the lower power level for the vertical scale. **Scale Mode:** Sets the vertical scaling to Automatic or Manual (Power Max (dBm) and Power Min (dBm) settings are not available when set to Automatic). Changes to these settings are applied by pressing the **Enter** key.
2	The vertical scale displays the power level in dBm.
3	The horizontal scale displays the time slots and may be increased or decreased from the "Time Slot Mode" settings area.
4	Graphical slot display showing the slot power level as a function of time slot number.
5	Marker showing as a vertical blue line with an x on the marker point and numerical values for the time slot number and power level (in dBm). The marker is available for reading power at an instant of time. It can be dragged with the mouse and can be centered in the display via the **Center marker** button.
6	Trigger Level Marker: Shows the current trigger level position. The trigger level is set via the "Trigger Settings" area.
7	Trigger Delay Time: Shows the current trigger delay position. The trigger delay is set via the "Trigger Settings" area. Note that the trigger marker will not be visible for positive trigger delays.

Figure 3-6. Anritsu PowerXpert Graphical Display Area (Time Slot Mode)

The following Power versus Time graph is used in "Scope Mode" and is available only with the MA24108A, MA24118A, and MA24126A power sensors.

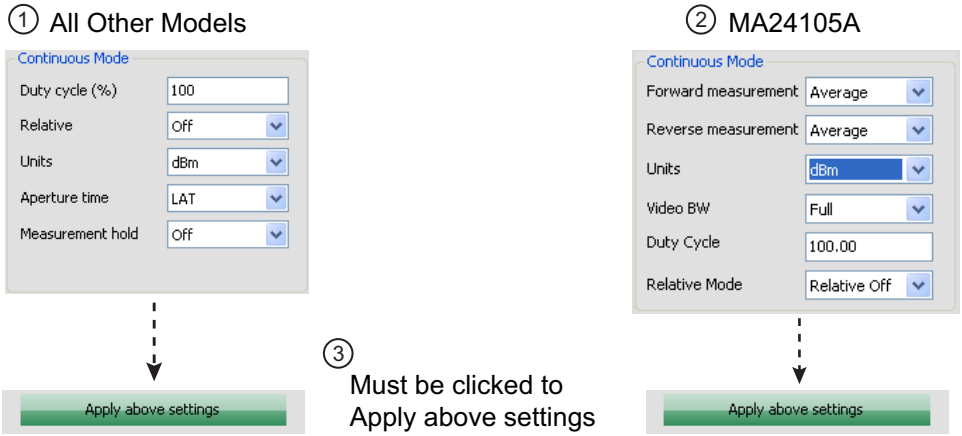


Index	Description
1	Graticule Settings: **Capture Time:** Displays the current capture time setting. This setting is changed via the "Scope Mode" settings area. **Power Max (dBm):** Sets the upper power level for the vertical scale. **Power Min (dBm):** Sets the lower power level for the vertical scale. **Scale Mode:** Sets the vertical scaling to Automatic or Manual (Power Max (dBm) and Power Min (dBm) settings are not available when set to Automatic). Changes to these settings are applied by pressing the **Enter** key.
2	The vertical scale displays the power level in dBm.
3	The horizontal scale displays the total capture time (in milliseconds) and may be increased or decreased from the "Scope Mode" settings area
4	Graphical trace display showing the power level as a function of time.
5	Marker showing as a vertical blue line with an x on the marker point and numerical values for the time (in milliseconds) and power level (in dBm). The marker is available for reading power at an instant of time. It can be dragged with the mouse and can be centered in the display via the **Center marker** button.
6	Trigger Level Marker showing the current trigger level position. The trigger level is set in the "Trigger Settings" area.
7	Trigger Delay Time showing the current trigger delay position. The trigger delay is set in the "Trigger Settings" area.
8	Gate Start (ms)
9	Gate End (ms)
10	Fence Start (ms)
11	Fence End (ms)

Figure 3-7. Anritsu PowerXpert Graphical Display Area (Scope Mode)

3-4 Continuous Mode

Continuous Mode is the default mode in which the PowerXpert starts and displays the average power of the input signal. In this mode, the sensor is "continuously triggered" and collects data at all times. The description of the Continuous Mode settings are given below:



Index	Description
1	All Models except MA24105A
2	Model MA24105A Only
3	Must be clicked to apply above settings.

Figure 3-8. Continuous Mode Settings (Aperture time settings vary depending on sensor model)

Duty Cycle

Duty cycle is available only with the MA24108A, MA24118A, and MA24126A power sensors. Duty cycle correction is applied (as a percentage) to the measured average power of a pulse modulated signal to obtain the pulse power. The duty cycle correction is used to find the power during the pulse, given a measurement of the average power of a pulse modulated signal for which the duty cycle is known, and is calculated as follows:

Linear units: *Pulse power = Average power / (duty cycle % / 100)*

dBm: *Pulse power = Average power – 10 x Log (duty cycle % / 100)*

Note	On the MA24105A sensor, Duty Cycle is only used for dedicated burst average measurement.

Relative

Relative measurement displays power changes with respect to the displayed power when relative mode is turned on. To reset the power reference, turn relative mode Off, and then back on. This mode is particularly useful to study drift or measure (loss of) attenuator and (gain of) amplifiers.

Units

Displays units of power in linear or log scale (dBm, µW, mW, or W).

Forward Measurement

Forward measurements listed below are available only with the MA24105A power sensor. Selectable forward measurement settings include:

- Average Power
- Crest Factor
- Burst Average User
- Peak Power
- Burst Average Auto
- CCDF

Reverse Measurement

Reverse measurements are available only with the MA24105A power sensor. Selectable reverse measurement settings include:

- Average Power
- Reflection Coefficient
- Return Loss
- VSWR

Video Bandwidth

Video Bandwidth settings are available only with the MA24105A power sensor. Selectable peak measurement video bandwidths include:

- Full
- 200 KHz
- 4 KHz

Aperture Time

The aperture time is the total time the sensor observes the input signal in order to make one power measurement. Settings vary depending on which power sensor is connected as follows:

MA24104A and MA24106A Power Sensors:

HAT (High Aperture Time): When High Aperture Time mode is selected, the sensor provides more accurate measurements of TDMA signals. In this mode, the ADC acquisition time is increased and the display update rate is decreased. This mode can be useful when measuring low power, modulated signals and when changing between ranges. With HAT selected, signals with pulse repetition periods as long as 50 ms can usually be measured.

LAT (Low Aperture Time): When Low Aperture Time mode is selected, the ADC acquisition time is decreased and the display update rate is increased. With LAT selected, the maximum recommended pulse repetition time is about 10 ms.

Refer to the “Measurement Considerations” section of your power sensor chapter for more details.

MA24108A, MA24118A, and MA24126A Power Sensors

If external averaging is selected, two or more of these measurements are averaged together to form the displayed power. PowerXpert automatically uses a default aperture time based upon the connected sensor. For example, when using MA24118A with a 20 ms aperture time, the sensor collects 2860 samples (with ~142 KHz sampling rate), and averages them together to compute the measurement value. Depending upon the measurement speed requirements or signal type, aperture time can be increased or decreased. For slow moving modulated signals, higher aperture time setting may be required to obtain stable readings. Refer to the "Measurement Considerations" section of your power sensor chapter for more details.

Note	Aperture Time is not available on the MA24105A sensor.

Measurement Hold

When set to On, holds the last sensor readings. When set to Off, the sensor continues to sample measurements. Measurement hold is not used on the MA24105A.

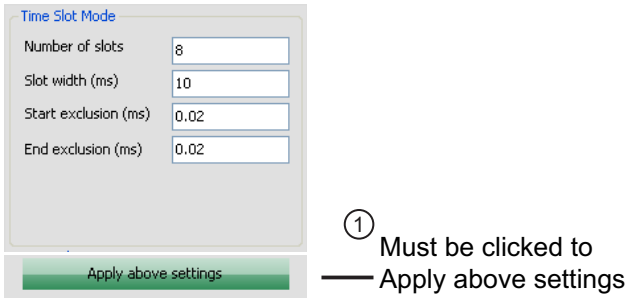
Apply Above Settings Button

The **Apply Above Settings** button applies all changes made to the "Continuous Mode" settings. Changes to these settings do not take effect until this button is clicked.

3-5 Time Slot Mode

Time Slot mode is only available with power sensor models MA24108A, MA24118A, and MA24126A. Time Slot mode is generally used for performing measurements on TDMA waveforms like GSM/EDGE. The slot mode breaks up the measurement into equal time slots and calculates the average power reading for each individual slot. The measurements need to be triggered internally or externally. Unwanted portions in the transition from one time slot to the next can be masked by user-definable exclusion periods. It is necessary that the waveform under test consists of equally spaced time slots and that the settings exactly match the waveform.

The descriptions of the Time Slot mode settings are given below:



Index	Description
1	Button must be clicked to apply above settings

Figure 3-9. Time Slot Mode Settings

Number of Slots

The number of time slots that make a single frame. PowerXpert can support up to 128 slots. A single marker can be set on a particular slot to read average power in that slot. The power reading is the average power of all the samples falling within that slot.

Slot Width

Slot width is the width of each slot in milliseconds. All slots in a single frame should have exactly the same width.

Start and End Exclusion

Start exclusion is the time in milliseconds to be excluded from the beginning of each slot for power calculation. End exclusion is the time in milliseconds to be excluded at the end of each slot for power calculation. This feature is generally used to define spacing between slots, although it may not be evident from the Time Slot mode graph. the following are general guidelines for Time Slot mode settings:

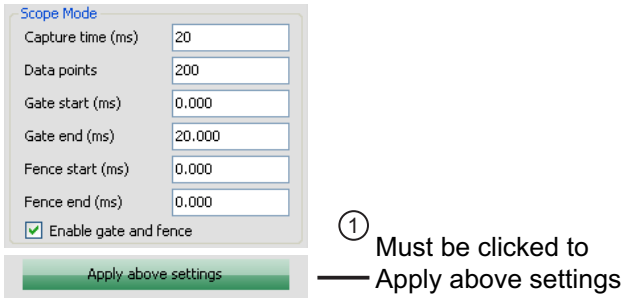
- The exclusions should not eclipse the entire slot width:
  `Start Exclusion + End exclusion < Slot width`
- The maximum capture time is limited by the sensor:
  `Slot width x Number of slots = Total capture time`

Apply Above Settings Button

The **Apply above settings** button applies all changes made to the "Time Slot Mode" settings. Changes to these settings do not take effect until clicking this button.

3-6 Scope Mode

Scope mode is only available with power sensor models MA24108A, MA24118A, and MA24126A. In Scope mode, the sensor acts similarly to an oscilloscope in that it can be used to measure power as a function of time. There are two parameters needed to define the scope mode operation: the capture time and the number of data points. Operation in scope mode proceeds as follows: sensor first waits for a trigger. Upon receiving a trigger, the sensor starts collecting data at its sample rate for the duration of the capture time. This will typically result in a number of samples that exceed the number of displayed data points. In this case, individual samples are averaged together to display the requested number of data points. The descriptions of the Scope mode settings are given below:



Index	Description
1	Button must be clicked to apply above settings

Figure 3-10. Time Slot Mode Settings

Capture Time

The Capture Time represents the time displayed on the screen at any one time. If a positive delay is specified for the trigger delay item, the capture time will commence once the specified delay has been reached.

Data Points

Scope mode can be used to look at very fine structures of a signal. When using marker, gate, and fence, the power of any specific time can be accurately measured. To better observe these fine signal structures, a graph capture time can be reduced to get better resolution. However, as capture time shrinks, the time intervals between data points on the graph also decrease. The capture time can continue to shrink until it approaches the absolute resolution limit.

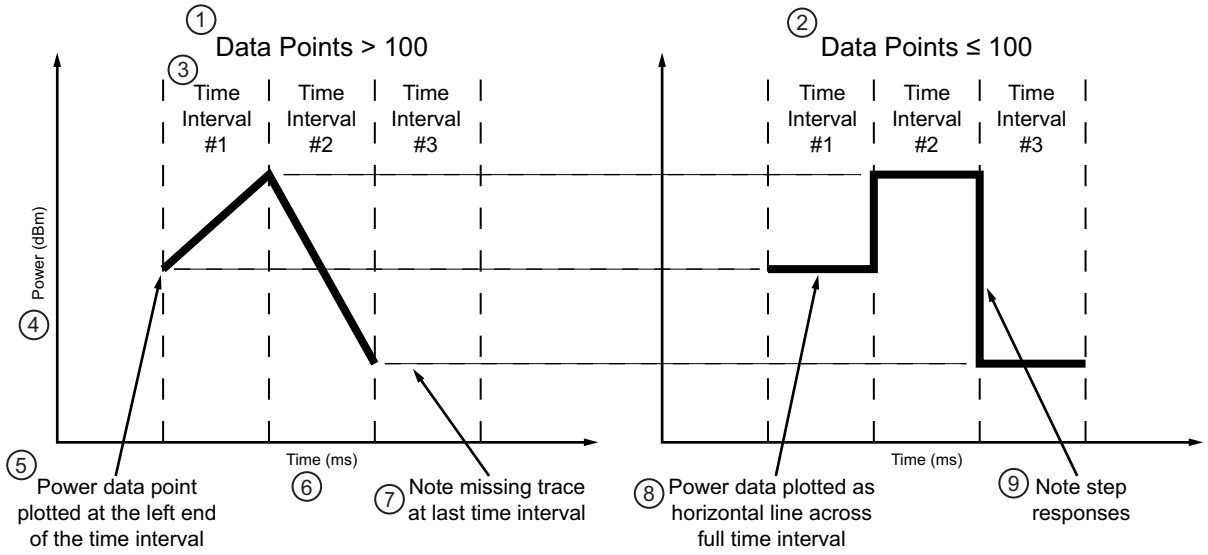
The sampling rate of the sensors is approximately 142 kHz, or 7 µs per sample. When the capture time divided by the number of points is at 7 µs, the resolution has reached its maximum. Any more reduction in capture time must be accompanied by a reduction in the number of data points such that:

$$(\text{capture time})/(\text{data point}) > 7\ \mu s$$

For example, in case of a MA24118A with 20 ms of capture time, there are 2860 samples. If there were 10 data points, then each data point consists of an average of 286 samples. The number of data points should not be less than the total number of samples. For a given capture time, the lower the number of data points the more samples that are averaged per point, thus the lower the trace noise.

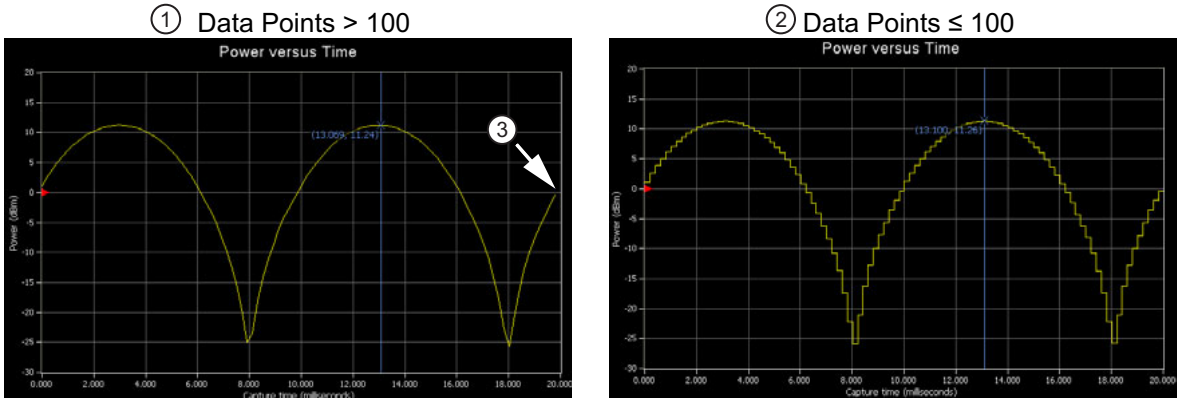
When there is a large number of points in a graph, the points are plotted at the beginning of the given time interval. For example, if a graph has a capture time of 100 ms and data points of 1000, then the first time interval is from time 0 µs to 100 µs (100 ms/1000). The power measured during this time interval is plotted as a point at time 0 µs. Subsequent intervals are plotted the same way until time interval 1000, where data is plotted as a point at time 99.9 ms. When there are many data points in a graph, not having a point at exactly 100 ms is not noticeable. However, when there are fewer points, then the graph seems incomplete (missing the last data point). One may perceive this as a time inaccuracy if not aware of how the graph is plotted.

When the number of points reaches 100, PowerXpert implements a different type of graphing that is more technically correct. Instead of plotting each time interval as a point, time intervals are plotted as a horizontal line between the start and the end of the time interval. For example, if a graph has a capture time of 1 ms and data points of 100, then the first time interval will be from 0 µs to 10 µs (1 ms/100). The power measured during this time interval is a horizontal line representing the measured power plotted between time 0 µs to 1 µs. Subsequent time intervals are plotted the same way until time interval 100, where a horizontal line is plotted between time 990 µs and 1 ms. The resulting power graph will look different as seen in Figure 3-11 on page 3-15:



Index	Description
1	Data Points > 100
2	Data Points ≤ 100
3	Time Intervals (#1, #2, #3)
4	Power (dBm)
5	Power data point plotted at the left end of the time interval
6	Time (ms)
7	Note missing trace at last time interval
8	Power data plotted as horizontal line across full time interval
9	Note step responses

Figure 3-11. Time Slot Mode Settings

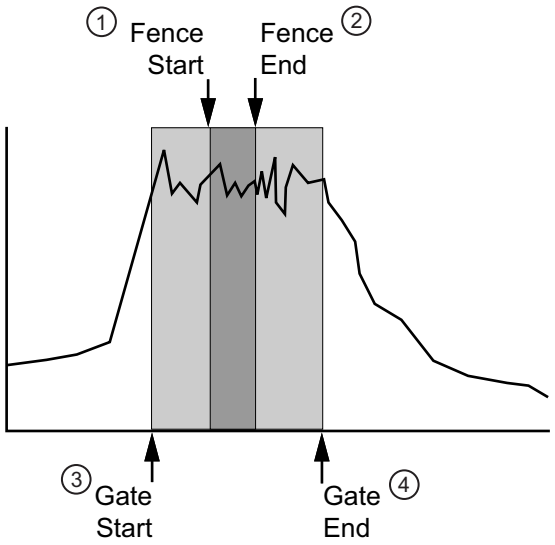


Index	Description
1	Data Points >100
2	Data Points ≤100
3	Note the missing trace at the last time interval in the plot on the left.

Figure 3-12. Data Points Plot Differences

Gate and Fence

The Gate and Fence feature enables measurement of the desired portion of the waveform. A Gate is a specification for extracting an averaged power reading measurement between two defined points on a pulsed waveform. A fence must be set up within the boundaries of a gate, unless the fence is disabled by setting the Fence start and end to zero, or to the same value. All data sampled between the fence start and end positions are excluded from the average power calculations for the gate. This is useful for purposes such as excluding a training sequence from an EDGE measurement.



Index	Description
1	Fence Start
2	Fence End
3	Gate Start
4	Gate End

Figure 3-13. Time Slot Mode Settings

Checking the **Enable gate and fence** box enables the feature in PowerXpert. All of the gate and fence settings are relative to the triggering event (start of capture). The fence must reside entirely within the gate, unless the fence is disabled by setting the Fence start and Fence end to zero. The gate and fence start and end points can be dragged by the mouse or directly entered (the **Apply above settings** button must be clicked to enable the changes to the gate and fence parameters made to the start and end points, even when dragging them with the mouse).

Certain restrictions and conditions apply when setting up gating and fence settings as listed below:

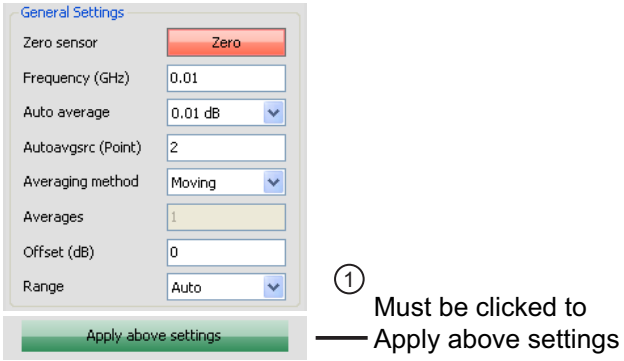
- Gate start cannot be negative and it cannot exceed the capture time.
- Gate end value cannot be less than gate start and cannot exceed the capture time.
- Fence start should be between Gate start and Gate end.
- Fence end should be between Fence start and Gate end.
- If the Fence start and Fence end values are the same, then the fence is disabled.
- Fence is disabled if both fence start and fence end are set to zero.
- The Fence start and Fence end positions cannot be set outside of the area defined by the Gate start and Gate end positions.
- The Gate start and Gate end points are included in the measurement.
- The Fence start and Fence end points are excluded from the measurement and have priority over the Gate start and Gate end points if they coincide.

Apply Above Settings Button

The **Apply above settings** button applies all changes made to the "Scope Mode" settings. Changes to these settings do not take affect until clicking this button.

3-7 General Settings

The PowerXpert general settings are common to all three modes and power sensors.



Index	Description
1	Button must be clicked to apply above settings

Figure 3-14. Time Slot Mode Settings

Zero Sensor

Zero the sensor before making power measurements. If frequent low-level measurements are being made, it is advised to check the sensor zeroing often and repeat as necessary. Before zeroing the sensor, connect it to the DUT (device under test) test port and remove RF power from the connection to a level 20 dB below the noise floor of the power sensor. For the MA24104A and MA24105A power sensors, this level is less than –20 dBm. For the MA24106A power sensor, this level is less than –60 dBm. For the MA24108A, MA24118A, and MA24126A, this level is less than –70 dBm. It is preferable to leave the sensor connected to the DUT test port so that ground noise and thermal EMF (electro-magnetic fields) are zeroed out of the measurement. The sensor may also be connected to a grounded connector on the DUT or disconnected from any signal source.

Frequency

Entering the frequency of measurement applies frequency correction to the measured power. The power sensor has an internal EEPROM containing frequency calibration factors that were programmed into the sensor at the factory. The power sensor has an internal temperature sensor that reports its readings periodically to the microprocessor. The sensor makes all of the required calculations on the measurement once entering the measurement frequency.

Auto Average

Auto average is only available with the MA24108A, MA24118A, and MA24126A power sensors. Auto average sets the auto averaging status and count. When an auto averaging resolution is selected, the sensor chooses an averaging number that is a compromise between stabilizing the power reading and providing reasonable settling time. It does this by choosing an averaging number based on the power level currently being measured. For most power levels, selecting auto averaging results in the power reading fluctuating by no more than twice the selected auto average resolution setting. However, near the low end of the measurement range, the power reading may fluctuate by more than this as the averaging number has been limited to maintain reasonable settling response time. Auto averaging only stabilizes the readings due to noise contributed by the power sensor electronics. Power variations that are the result of measuring modulated signals are not taken into account by the sensor in auto averaging. Setting Auto average to Off enables manual averaging.

Note	Auto averaging source is only available with the MA24108A, MA24118A, and MA24126A power sensors.

Auto Averaging Source

Auto averaging source is only available with the MA24108A, MA24118A, and MA24126A power sensors. Auto averaging source sets which display point or slot number to use for auto averaging. The auto averaging algorithm can only use one averaging number at a time and this point or slot number must be specified when "Auto Average" is enabled. Auto averaging source is only available in "Scope Mode" (to specify which point to use) and in "Time Slot Mode" (to specify which slot number to use).

Averaging Method

Averaging method is only available with the MA24108A, MA24118A, and MA24126A power sensors.

Moving: Averaging is continuously performed over the number of specified measurements. When the specified number is reached the average is calculated and as the next measurement is finished the average is recalculated from the new start and end positions. Refer to the figure below that shows moving averaging performed over eight measurements.

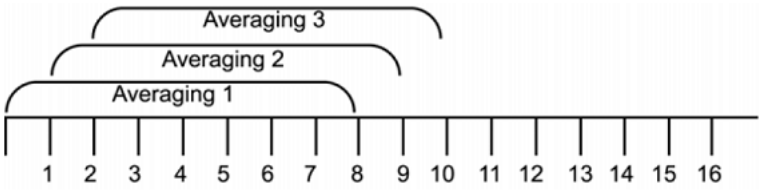


Figure 3-15. Moving Averaging

Repeat: Averaging is performed over the number of measurements specified. The displayed power is not updated until the next entire batch of measurements is complete. Refer to the figure below that shows repeat averaging performed over 8 measurements.

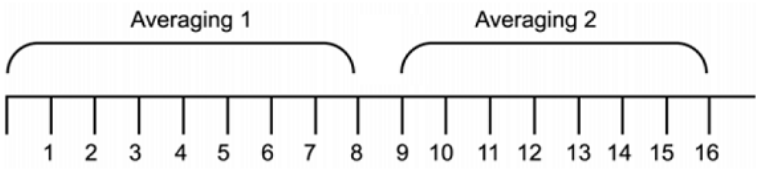


Figure 3-16. Repeat Averaging

Averages

The Averages setting allows you to specify the number of measurements that are averaged to calculate the displayed power. A setting of 1 disables averaging. This setting is only available when "Auto Average" is Off.

Offset

A fixed value (in dB) specified by the user is applied as a power offset to the sensor. A positive offset adds a value to the power readings and can be used to compensate for attenuators, couplers, limiters, and other lossy devices. A negative value subtracts a value from the power reading and can be used to compensate for amplification in the measurement path.

Range

Range allows the operating power range of the sensor to be set to the desired range. Setting to "Auto" means that sensor firmware determines the appropriate range for it to operate. Setting to Range 1 covers the power range from +20 dBm to –7 dBm. Setting to Range 2 covers the power range from –7 dBm to –40 dBm.

For model MA24105A, setting to Range 1 covers the power range from +3 dBm to +38 dBm. Setting to Range 2 covers the power range from +38 dBm to +51.76 dBm (150 W).

In some instances, setting the range manually improves the measurement. For example, a low duty cycle, high crest factor signal, where average power may fall in one range and the peak power in another, may result in erroneous readings when the sensor is set to auto range. In this case, setting the range manually closer to the anticipated average power will increase the accuracy.

Apply Above Settings Button

The **Apply above settings** button applies all changes made to the "Continuous Mode" settings. Changes to these settings do not take affect until clicking this button.

3-8 Trigger Settings

Trigger settings are only available in Time Slot Mode and Scope Mode with power sensor models MA24108A, MA24118A, and MA24126A. Trigger is an event that initiates a measurement run. When the sensor is armed, it starts looking for the trigger. Once the trigger occurs, the sensor starts collecting data and measurement commences. Before arming the sensor, the sensor must be set up with the following trigger related parameters:

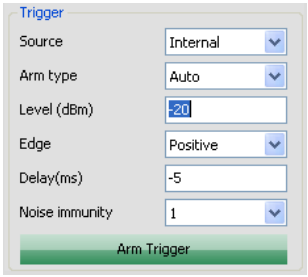


Figure 3-17. Trigger Settings

Trigger Source

- **Continuous Trigger:** The sensor continuously collects data when the trigger source is set to continuous and does not look for any trigger event. Continuous trigger does not depend on any other trigger related parameters and these settings are unavailable for a Continuous trigger source.
- **Internal Trigger:** If internal trigger source is selected, the sensor triggers based on the signal level, edge/slope and noise immunity factor.
- **External Trigger:** When the sensor is setup with external trigger, it is triggered by the TTL/CMOS signal on the external trigger pin. In this trigger source, sensor can be set up to trigger at a particular edge of the TTL/CMOS signal. External trigger does not depend on any other trigger related parameter.

Trigger Arm Type

The trigger parameters are effective only if the sensor is armed. “Armed” is the state when the sensor is looking for a trigger. By default, the sensor is in Standby mode, it has to be armed before it starts looking for trigger. Trigger arming is effective only when the trigger source is set to internal or external. It does not play any role when the trigger source is continuous. An armed sensor returns the power automatically after a trigger has occurred and data has been collected and processed. The trigger can be armed in following ways:

- **StandBy:** This is the default arming state of the sensor. If the trigger source is internal or external, and the arm type is stand by, then the sensor will not make measurements or update the trace data. This is similar to the “stop” acquisition function of a digital oscilloscope. However, if the trigger source is continuous, then the sensor continuously collects and updates trace data.
- **Auto Arm:** In this state, the sensor rearms automatically after a trigger event has occurred and power is displayed. It is generally used to evaluate periodic waveforms. In other words, the sensor rearms after every measurement run. The power is displayed/updated automatically after every trigger event.
- **Single Arm:** The trigger is first armed and, once the trigger event occurs, the data is collected and the display updated, then the trigger is unarmed. Thus, only one measurement run and display update is performed. This mode is generally used to evaluate non-periodic waveforms. If averaging is selected, the results will not usually be very meaningful because all of the measurement runs commence with only the one trigger event and occur successively. The individual measurement runs are not synchronized to the input signal; therefore, averaging should not normally be used with the single arming type.
- **Multiarm:** Multiarming is used when averaging is needed, but continuous display updates are not needed. In this mode the trigger is armed, then once the trigger event occurs, the measurement data is taken and the display is updated (for the moving average method). Then the trigger is rearmed. This cycle repeats N times where N is the current averaging number. If the averaging method is *Moving*, then the display is updated after each trigger and measurement run. If the averaging method is *Repeat*, then the display is updated only after N triggers and measurement runs. Once N runs are complete, the trigger is unarmed.

Trigger Level

Sets the power level threshold of the waveform under test that, when crossed, triggers a measurement. It is used during internal triggering only.

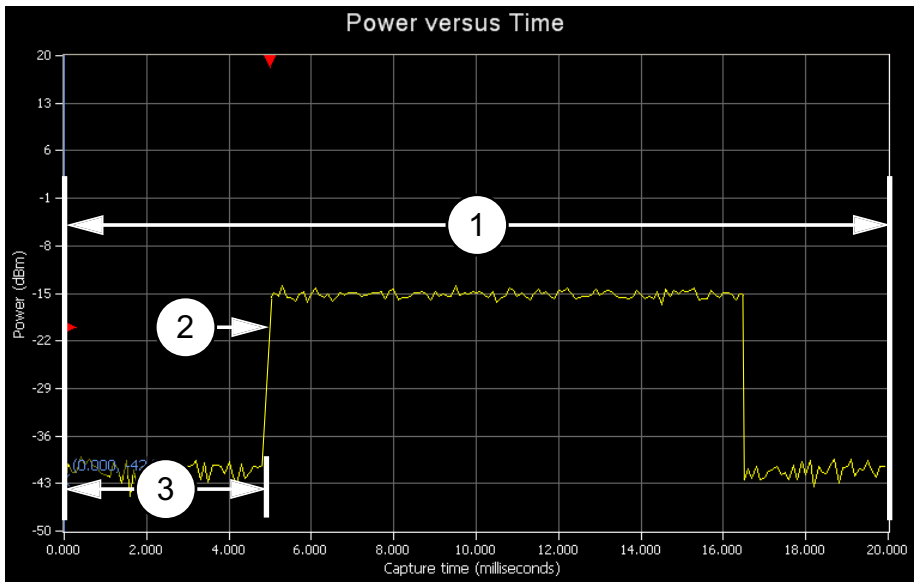
Trigger Edge

It sets the trigger edge for internal and external trigger. Trigger edge can be set to positive or negative. For internal trigger, the sensor triggers only when the signal crosses the trigger level from high to low when set to negative edge; the sensor triggers only when the signal crosses the trigger level from low to high when set to positive. For external trigger, the sensor triggers when the TTL signal on the external trigger pin falls from high to low when set to negative; the sensor triggers when the TTL signal on the external trigger pin rises from low to high when set to positive.

Trigger Delay

A trigger delay allows a time lag (positive or negative) between the trigger event and the data displayed on the screen.

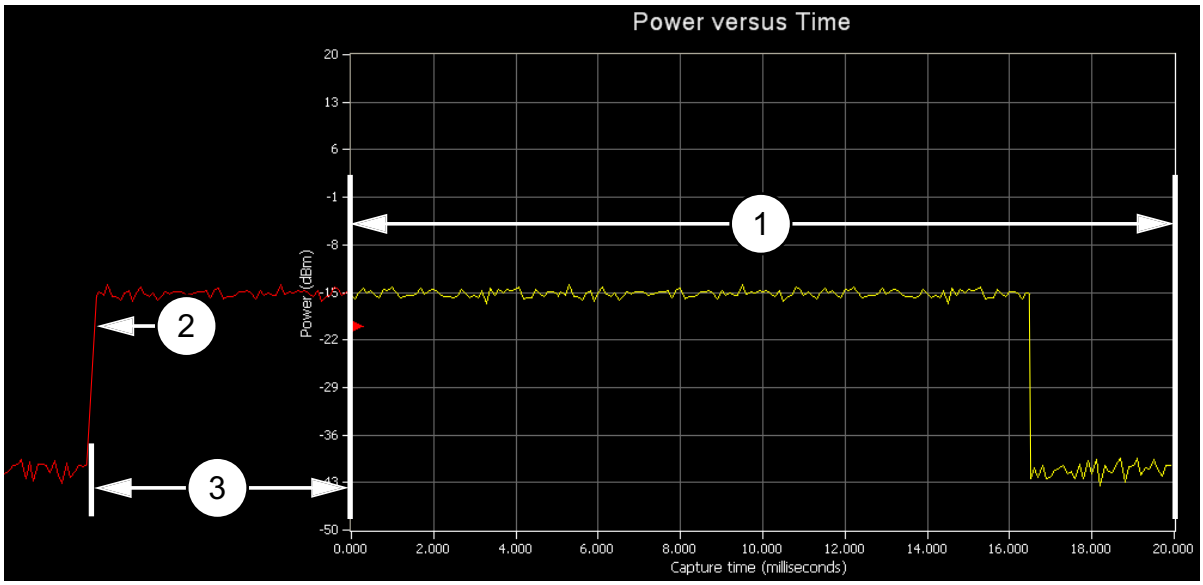
Specifying a positive delay has the affect of displaying data occurring some time after the trigger event. When the delay is positive, the sensor waits for the set delay time after a trigger before it starts taking readings. The sensor is unresponsive during the wait period and cannot be aborted. For example, for a capture time of 20 ms and a delay of 1 ms, the length of the capture would be from 1 ms to 21 ms given that the trigger occurs at time, t = 0. The capture time is unaffected by a positive trigger delay.



Index	Description
1	Capture Time (ms)
2	Trigger Level (dBm) and Positive Edge Trigger
3	Negative Trigger Delay Time (ms)

Figure 3-18. Trigger Parameters

Specifying a negative delay allows the user to display data occurring immediately before the trigger event. The negative delay cannot be greater than or equal to the capture time. If the capture time conflicts with the trigger delay, an error is generated.



Index	Description
1	Capture Time (ms)
2	Trigger Level (dBm) and Positive Edge Trigger
3	Positive Trigger Delay Time (ms)

Figure 3-19. Trigger Parameters

Noise Immunity

This feature is available during internal triggering. For very noisy signals, the sensor can trigger at an undesired point or edge. To provide immunity against such situations, the sensor can be set to wait for N number of samples to cross the trigger level before it triggers. Higher values of N result in increased noise immunity, but also increase the trigger latency. It is advised to use a negative trigger delay when using noise immunity. The negative delay required to reduce the trigger latency is the product of N and the sample duration of the power sensor (see sensor specifications), which is approximately 7 µs for the MA24108A and MA24118A. The default value for the trigger noise immunity factor is 1 (no immunity).

Arm Trigger Button

The **Arm trigger** button becomes available in "Time Slot Mode" or "Scope Mode" when the "Trigger Settings" have been changed. It may also become available in other conditions such as trigger timeout. Clicking the button applies the trigger settings and arms the trigger. PowerXpert may not be actively taking data and updating the graph when the **Arm trigger** button is available and has not been clicked.

3-9 Tools

The Tools menu provides the option of zeroing all sensors, capturing the PowerXpert screen display, enabling the log data and offset table features, and updating the sensor firmware.

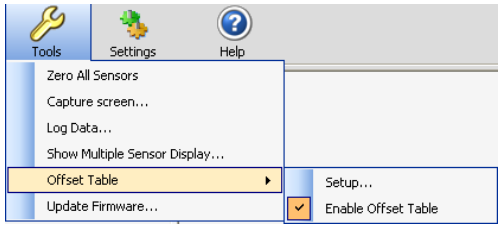


Figure 3-20. Tools Menu

Zero All Sensors

Zero All Sensors provides a convenient method of zeroing all connected sensors. Zero all sensors before making power measurements. If frequent low-level measurements are being made, it is advised to check the sensor zeroing often and repeat as necessary. Before zeroing the sensor, connect it to the DUT (device under test) test port and remove RF power from the connection to a level 20 dB below the noise floor of the power sensor. For the MA24104A and MA24105A power sensors, this level is less than –20 dBm. For the MA24106A power sensor, this level is less than –60 dBm. For the MA24108A, MA24118A, and MA24126A, this level is less than –70 dBm. It is preferable to leave the sensor connected to the DUT test port so that ground noise and thermal EMF (electro-magnetic fields) are zeroed out of the measurement. The sensor may also be connected to a grounded connector on the DUT or disconnected from any signal source.

Capture Screen

The Capture Screen utility captures a PowerXpert screenshot and launches the Save image dialog that allows you to save the image in BMP, JPEG, PNG, or GIF file formats.

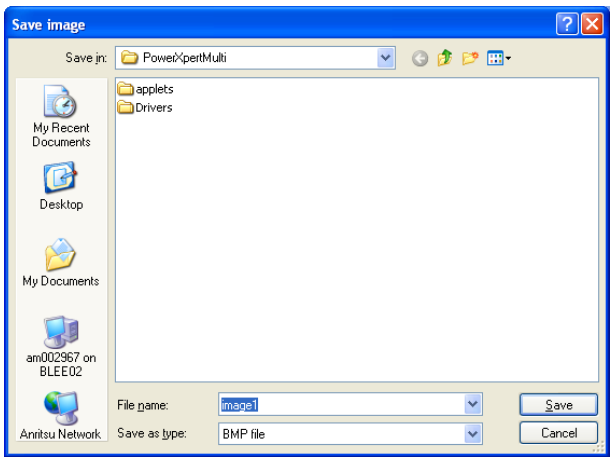


Figure 3-21. Save Image Dialog

Log Data

The Log Data feature provides the ability to record data in a comma separated value file and is accessed from the **Tools | Log Data** toolbar. This feature is available only when the application is in Continuous Average mode. Data logging is set up in the dialog below:

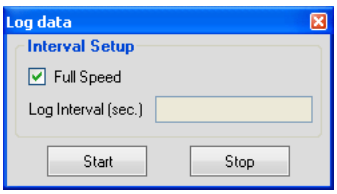


Figure 3-22. Log Data Dialog

- **Interval Setup:** Sets full speed data or fixed interval data logging (user defined logging interval).
- **Log Interval (sec.):** Sets the time interval in which to log data and is available when Full Speed is deselected.

Note	Log Interval should be set to reduce the number of data points when capturing long time periods as Microsoft Excel has a limitation of 65536 data records. The file size should be limited to 10 MB.

Data is stored as comma separated value (.csv) files that can be directly opened in Microsoft Excel. The filename and location can be selected or changed as desired. The default filenames have the following format:

```
Test_yyyy_mm_dd_hhmmss.csv
```

where:

- **yyyy:** Four-digit year
- **mm:** One- or two-digit month
- **dd:** One- or two-digit day
- **hhmmss:** Two digit hours (24-hour clock), minutes, and seconds

The Save As dialog is shown when the **Start** button is pressed.

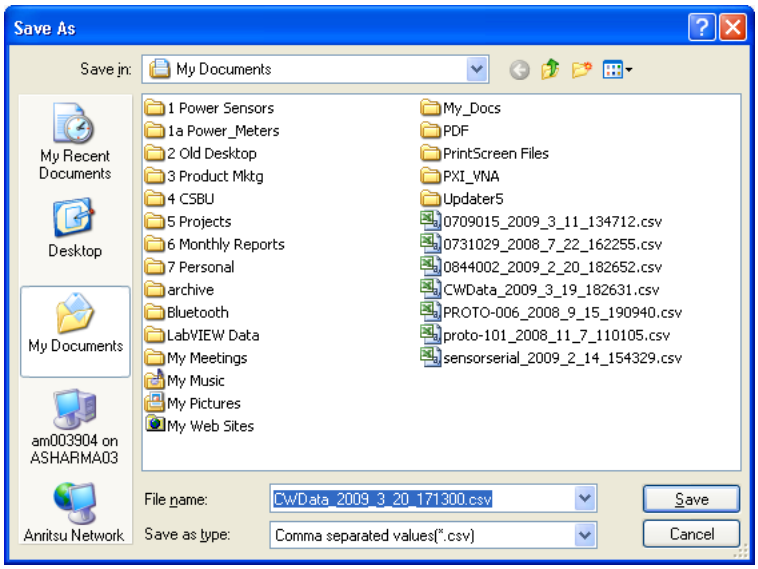
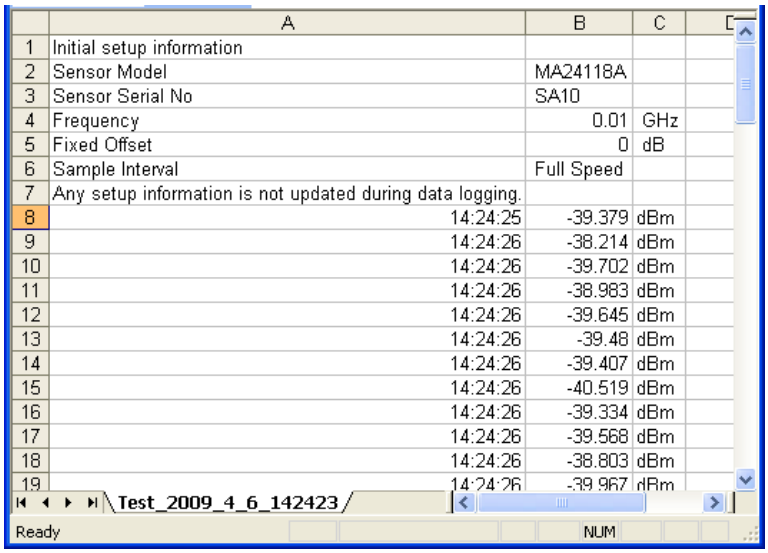


Figure 3-23. Log Data Save As Dialog

Sample log data is shown in a Microsoft Excel spreadsheet file below:



	A	B	C
1	Initial setup information		
2	Sensor Model	MA24118A	
3	Sensor Serial No	SA10	
4	Frequency	0.01	GHz
5	Fixed Offset	0	dB
6	Sample Interval	Full Speed	
7	Any setup information is not updated during data logging.		
8	14:24:25	-39.379	dBm
9	14:24:26	-38.214	dBm
10	14:24:26	-39.702	dBm
11	14:24:26	-38.983	dBm
12	14:24:26	-39.645	dBm
13	14:24:26	-39.48	dBm
14	14:24:26	-39.407	dBm
15	14:24:26	-40.519	dBm
16	14:24:26	-39.334	dBm
17	14:24:26	-39.568	dBm
18	14:24:26	-38.803	dBm
19	14:24:26	-39.967	dBm

Test_2009_4_6_142423

Ready NUM

Figure 3-24. Log Data

Data logging is stopped by accessing the **Tools | Log Data** toolbar and pressing **Stop** in the Log data dialog.

Multiple Sensor Display

PowerXpert offers a Multiple Sensor Display screen that can show simultaneous measurements of up to eight sensors. This display is in addition to the normal PowerXpert display and is enabled by clicking **Tools | Show Multiple Sensor Display**.

Figure 3-25. PowerXpert Multiple Sensor Display

When using multiple sensors, the sensor parameters are applied to the selected sensor in the Sensor Information area.

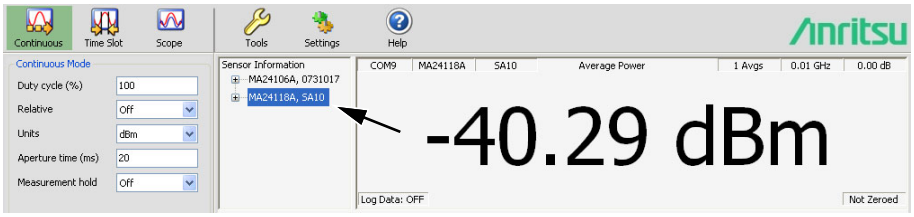


Figure 3-26. Selecting Sensor

View Summary

For the MA24105A, PowerXpert offers a View Summary Display screen (Figure 3-27) that can show simultaneous forward and reverse measurements including:

- Forward Average Power
- Forward Crest Factor
- Forward Burst Average
- Forward Peak Power
- Reverse Average Power
- Reverse Refection Coefficient
- Reverse Return Loss
- Reverse VSWR.

This display, in addition to the normal PowerXpert display, is enabled by clicking Tools | View Summary.

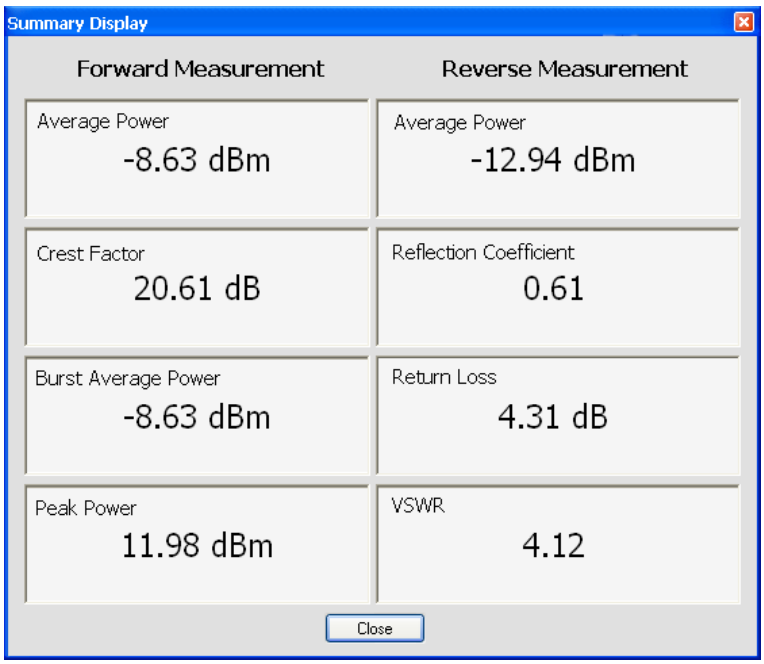


Figure 3-27. View Summary Screen

Offset Table

Offset Table feature is only available with the MA24104A and MA24106A power sensors. Offset table provides the ability to apply corrections to measurements when RF devices are used between the sensor and DUT. Offset Table is different from Fixed Offset as it provides the ability to enter different offset values at different frequencies for an RF device. The frequency response of that device needs to be known before it can be entered. Offset Table employs linear interpolation to determine offset values for intermediate frequencies. In cases where the cal factor frequency is higher than the highest frequency in the offset table, then the offset for the highest frequency in the table is used. Similarly, when the cal factor frequency is lower than the lowest frequency in the offset table, then the offset for the lowest frequency in the offset table is used. The procedure for setting, saving, recalling, and applying the offset table is as follows:

1. Click **Tools** | **Offset Table** | **Setup**.

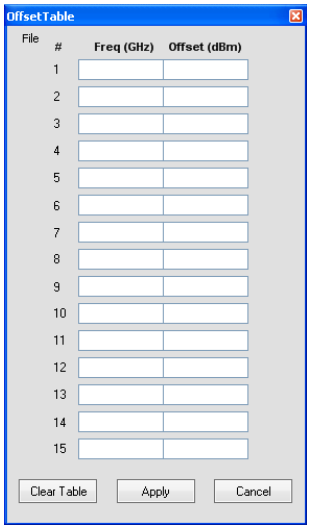


Figure 3-28. Offset Table

2. In the resulting dialog enter the frequency response of the RF device manually or by importing an S2P file used to measure the DUT.

Note	Positive values in dB are used for attenuation.

3. Click **Apply** in the Offset Entry screen to correct the measurement. “Offset table applied” appears briefly in the display window indicating that an offset table correction is applied to the current measurement. Also, a check mark is applied in front of the **Enable Offset Table** selection in the **Tools** | **Offset Table** menu.
4. To clear all of the entries in the table, click the **Clear Table** button.
5. Save the response of the device by clicking Save from the Offset Entry Screen and save as a file in the directory of your choice (see Figure 3-16). Any number of device responses can be stored. The files are stored as comma separated value files (.csv).
6. To recall a response, click **File** | **Open** in the Offset Table dialog, select the file, and then click Apply. Similarly, S2P files can be imported by selecting **File** | **Import S2P file** in the Offset Table dialog.
7. To remove the offset table correction, click **Tools** | **Offset Table** | **Enable Offset Table**. to remove the check mark. “Offset table disabled” appears briefly in the display window indicating that an offset table correction is no longer applied to the current measurement.

Updating the Firmware

Refer to ‘Upgrading the Firmware” in Appendix B.

3-10 Settings

The Settings menu is only available with the MA24108A, MA24118A, and MA24126A power sensors. The Settings menu provides for saving and recalling PowerXpert setups, resetting PowerXpert, setting the sensor time out, and enabling secure mode.

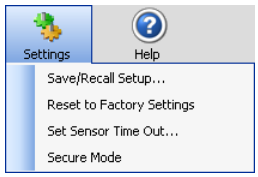


Figure 3-29. Settings Menu

Saving and Recalling Settings

The current settings can be saved to any one of ten non-volatile storage locations. If the storage location was already in use, the previously stored settings are automatically overwritten.

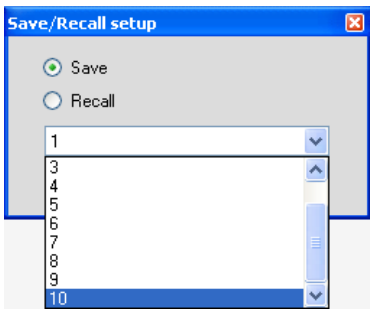


Figure 3-30. Save/Recall Setup Dialog

Any of the sensor settings that were saved in the manner described above can be recalled for use at any time.

Note	Trigger Arm Type, Units, and a fixed Offset value are not stored as part of the saved setup and will not be recalled.

Resetting to Factory Settings

This selection resets PowerXpert and the power sensor to their default state.

Sensor Time Out Setting

Sensor Time Out is a PowerXpert feature. It is active during internal or external triggering only (Time Slot and Scope modes). It is provided for situations where a trigger event may not occur for a long period of time (greater than a default of 10 seconds).

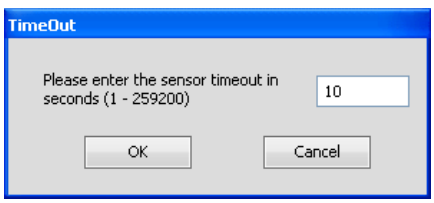


Figure 3-31. Sensor TimeOut Dialog

During triggering (internal or external), the sensor sends the data to the application after it receives a trigger. If the PowerXpert application does not receive any data from the sensor for the set timeout period, then the user is informed and is prompted to re-arm the sensor.

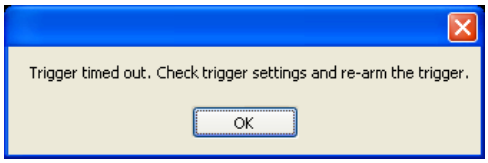


Figure 3-32. Trigger Timed Out Dialog

If there is no response from the sensor after re-arming of the trigger, the PowerXpert application will display the “No sensor” message.

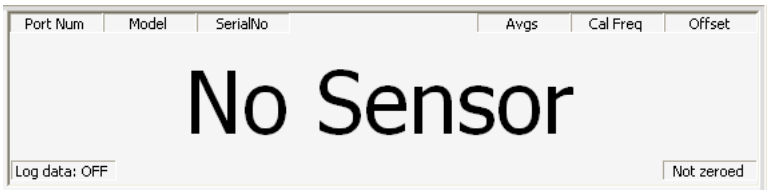


Figure 3-33. No Sensor Connected

If the sensor acknowledges the trigger arming, then the application understands that there was no trigger and will again wait for the data. If the data still does not come, the cycle repeats.

If the trigger event does not occur for a long time, then the length of the sensor’s timeout needs to be increased or the trigger needs to be re-armed manually.

There are two possible reasons for not receiving data:

- There may not have been a trigger event.
- There may be a problem with the sensor (communication or otherwise). In this case:
  1. Close the application and disconnect sensor.
  2. Open application and reconnect the sensor.
  3. If the problem persists, contact an Anritsu service center.

Secure Mode

The MA24104A and MA24106A USB power sensors have two different types of memory devices:

- Non-Volatile 32 KB FLASH memory within the PIC18F4550 micro-controller. This contains firmware for the sensor. This memory is not accessible by the user.
- Non-Volatile 8 KB EEPROM. This contains sensor factory calibration data and sensor information like Serial no, Model no etc. This memory is not accessible by the user.

  The MA24104A and MA24106A are inherently secure devices and can be moved in and out of the secure facilities as there are no user accessible locations in these sensors.

The MA24105A, MA24108A, MA24118A, and MA24126A USB power sensors have three different types of memory devices:

- Non-Volatile 512 KB FLASH memory within the AT91SAM7SE512 micro-controller. This contains firmware for the sensor. User cannot write to or access this memory.
- Volatile 32MB SDRAM. This contains program variables, buffers and calibration data information while sensor is in operation. This is initialized on power up and wiped clean when powered down. The user cannot write to this memory directly, and it is completely cleared during power down. This memory is not accessible by the user.
- Non-Volatile 4MB Data FLASH. Contains sensor factory calibration data, user setups (user setups are not used on MA24105A) and sensor information like Serial no, Model no etc. The user cannot write to this memory directly.

  In the MA24108A, MA24118A, and MA24126A, the user can store and retrieve instrument set ups in this memory. It can be completely cleared using the secure mode procedure. (The MA24105A does not use this feature because it is an inherently secure device.)

Clearing the Non-Volatile Data Flash

Information such as a user-defined setup saved in the sensor needs to be removed from the USB power sensors if it is moved out of a secure facility. This can be accomplished by using the secure mode to completely wipe the non-volatile, 4 MB DATA FLASH of all user-saved information. The user sets the secure mode via PowerXpert. When PowerXpert is next started, the non-volatile flash is completely purged of all user-saved information. The power sensor then sets the factory defaults for the current settings.

Click **Settings** | Secure Mode. A warning dialog box appears.

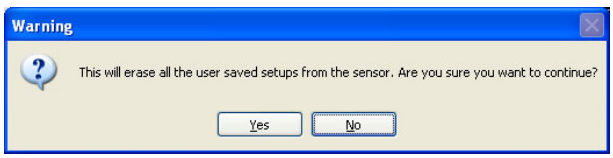


Figure 3-34. Secure Mode Warning

Click **OK**. Shut down and then restart PowerXpert. The power sensor now powers up with the non-volatile memory completely purged. The secure state can also be set over the USB using the “DELETE” remote command.

3-11 Help

The Help menu provides options to launch the online documentation and provides an informational About dialog.

Figure 3-35. About PowerXpert

Chapter 4 — Power Sensor Care

4-1 Introduction

Anritsu Power Sensors are high quality precision laboratory instruments and should receive the same care and respect afforded such instruments. Follow the precautions listed below when handling or connecting these devices. Complying with these precautions will guarantee longer component life and less equipment downtime due to connector or device failure. This will ensure that power sensor failures are not due to misuse or abuse – two failure modes not covered under the Anritsu warranty.

Warning	Beware of destructive pin depth of mating connectors.

Based on RF components returned for repair, destructive pin depth of mating connectors is the major cause of failure in the field. When an RF component connector is mated with a connector having a destructive pin depth, damage will usually occur to the RF component connector. A destructive pin depth is one that is too long in respect to the reference plane of the connector (see Figure 4-1 on page 4-5).

Warning	Beware of RF components that may not have precision type connectors.

The center pin of a precision RF component connector has a precision tolerance measured in mils (1/1000 inch). The mating connectors of various RF components may not be precision types. Consequently, the center pins of these devices may not have the proper pin depth. The pin depth of DUT connectors should be measured to assure compatibility before attempting to mate them with Power Sensor connectors. An Anritsu Pin Depth Gauge (Figure 4-2 on page 4-6), or equivalent, can be used for this purpose.

4-2 Power Sensor Precautions

Avoid Over Torquing Connectors

Over torquing connectors is destructive; it may damage the connector center pin. A torque wrench (12 lbf·in or 1.35 N· m) is recommended for tightening N connectors. Always use a torque wrench (8 lbf·in or 0.90 N· m) for K type connectors. Never use pliers to tighten connectors. Refer to Section 4-4 “Connection Techniques” on page 4-3 for detailed instructions.

Avoid Mechanical Shock

Power Sensors are designed to withstand years of normal bench handling. However, do not drop or otherwise treat them roughly. Mechanical shock will significantly reduce their service life.

Avoid Applying Excessive Power

Exceeding the specified maximum input power level will permanently damage power sensor internal components and render it useless.

Observe Proper ESD Precautions

Power sensors contain components that can be destroyed by electrostatic discharge (ESD). Therefore, power sensors should be treated as ESD-sensitive devices. To prevent ESD damage, do not handle, transport or store a power sensor except in a static safe environment. A static control wrist strap MUST be worn when handling power sensors. Do not use torn or punctured static-shielding bags for storage of sensors. Do not place any paper documents such as instructions, customer orders or repair tags inside the protective packaging with the sensors.

Clean the Connectors

The precise geometry that makes the RF component's high performance possible can easily be disturbed by dirt and other contamination adhering to the connector interfaces. When not in use, keep the connectors covered. Connectors must be cleaned using a lint-free cotton swab that has been dampened with isopropyl alcohol (IPA). Refer to Section 4-6 "Connector Cleaning" on page 4-7 for specific details.

Avoid Damage to Communication Connector and Cable

Use care when connecting the USB cable to the sensor. Ensure it is properly secured to avoid damage from connector movement while in its receptacle.

4-3 RF Connector Precautions

Handle With Care

RF connectors are designed to withstand years of normal bench handling. However, do not drop or otherwise treat them roughly. They are laboratory-quality devices, and like other such devices, they require careful handling.

Keep Connectors Clean

Avoid touching connector mating planes with bare hands. Natural skin oils and microscopic dirt particles are very hard to remove.

When using cotton swabs to clean connectors, make sure that you don't damage the center conductor. Refer to Section 4-6.

Check the Pin Depth

Always check the pin depth of a new connector before use to determine if it is out of spec. One bad connector can damage many. The connector can be damaged by turning in the wrong direction. Turning right tightens and turning left loosens.

Teflon Tuning Washers

The center conductor on most RF components contains a small teflon tuning washer located near the point of mating (interface). This washer compensates for minor impedance discontinuities at the interface. The washer's location is critical to the RF component's performance. *Do not disturb it.*

Align Before Connecting

To avoid center conductor damage, ensure the connectors you are joining are properly aligned.

Torque Properly

Over torquing connectors is destructive; it may damage the connector center pin. *Never* use pliers to tighten connectors. For other connectors, use the correct torque wrench.

Cover the Connectors

Put ESD-safe dust caps on the connector after use.

Store Properly

Never store adapters loose in a box, in a desk, or in a drawer.

4-4 Connection Techniques

Connection Procedure

Table 4-1 lists the Anritsu Company torque wrench and open end wrench part numbers for connectors used on USB power sensors.

Table 4-1. Connector Wrench Requirements – Torque Wrenches and Settings – Open End Wrenches

Connector Type	Torque Wrench Model Number	Torque Specification	Open End Wrench
K (2.92 mm)	01-201	8 lbf·in (0.90 N·m)	01-204
N	01-200	12 lbf·in (1.35 N·m)	01-202

Connecting

1. Carefully align the connectors.

   The male connector center pin must slip concentrically into the contact fingers of the female connector.

2. Push connectors straight together.

   Do not twist while pushing them together. As the center conductors mate, there is usually a slight resistance.

3. Finger tighten the connection by turning the connector nut.

   Do not turn the connector body.

   Do not pre-tighten so much that there is no rotation of the nut when using the torque wrench.

4. Back off the connection by turning the connector nut counter clockwise 1/4 turn.

   The final tightening will be done using the torque wrench.

Torquing

1. Hold torque wrench at the end.

Caution	Holding the torque wrench elsewhere applies an unknown amount of torque and could damage contacts and/or connectors.

2. Rotate *only* the connector nut as you tighten the connector.

   Use an open-end wrench to keep the body of the connector from turning.

3. Keep the two wrenches at a relative angle of less than 90°.

   Using an angle greater than 90° causes the connector devices to lift up and tends to misalign the devices and stress the connectors. This becomes more of a problem when there are several devices connected to each other.

4. Tighten the connection until the torque wrench handle just breaks.

   Breaking the handle fully can cause the wrench to kick back and may loosen the connection.

Disconnection Procedure

1. Use an open end wrench to prevent the connector body from turning.
2. Use another wrench to loosen the connector nut.
3. Complete the disconnection by hand, turning *only* the connector nut.
4. Pull the connectors straight apart without twisting or bending.

4-5 RF Connector Preventive Care

Most coax connectors are assembled into a system and forgotten, but some, especially on test equipment are used almost continuously. The care and cleaning of these connectors is critical to accurate and reliable performance. Remember that all connectors have a limited life time and usually a maximum connect/disconnect specification, typically about 5,000 connections. Most will last well beyond this number, but poor usage and poor care can destroy a connector well before that number. Good connector performance can be achieved with the following:

- Periodic visual inspection
- Appropriate gauging techniques
- Proper connection and disconnection techniques using torque wrench
- Proper cleaning

Visual Inspection

To ensure a long and reliable connector life, careful visual inspection should be performed on the connectors before they are used on a particular job at a minimum of once per day when the item is being used. A “good” connector may get damaged if it is mated with a “bad” one.

Magnification

The minimum magnification for connector inspection for damage varies with the connector:

- 7X for K (2.92 mm) connectors
- 2X for N connectors

Any connector with the following defects should be repaired or discarded:

Plating

- Deep scratches showing bare metal on the mating plane
- Bubbles and blisters

The connectors may lose some gloss over time due to usage. Light scratches, marks and other cosmetic imperfections can be found on the mating plane surfaces. These should be of no cause for concern.

Threads

- Damaged threads. Don’t force the connectors to mate with each other if the threads are damaged.

Center conductors

- Bent, broken or damaged contacts.

Pin Depth Measurement

Precautions

Warning	Beware of destructive pin depth of mating connectors.

A connector should be checked before it is used a minimum of once per day. If the connector is to be used on another item of equipment, the connector on the equipment to be tested should also be gauged.

Connectors should never be forced together when making a connection since forcing often indicates incorrectness and incompatibility. There are some dimensions that are critical for the mechanical integrity, non-destructive mating and electrical performance of the connector. Connector gauge kits are available for many connector types. Please refer to Anritsu Application Note 10200-00040. The mechanical gauging of coaxial connectors will detect and prevent the following problems:

Positive Pin Depth

Positive pin depth can result in buckling of the fingers of the female center conductor or damage to the internal structure of a device due to the axial forces generated.

Caution	Never make a connection when any positive pin depth condition exists.

Negative Pin Depth

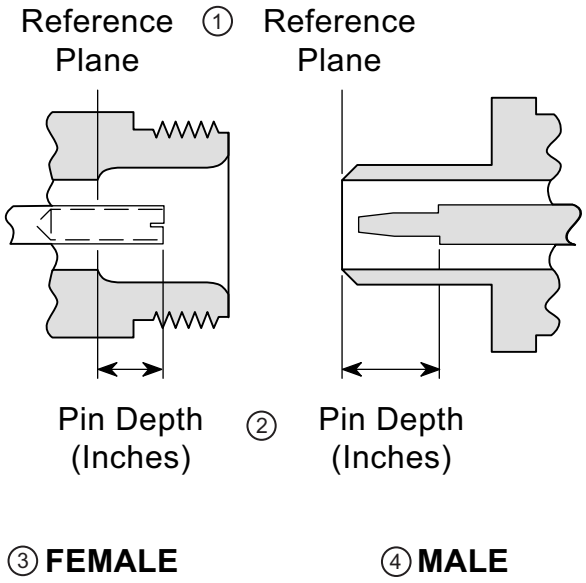
Negative pin depth can result in poor return loss, possibly unreliable connections, and could even cause breakdown under peak power conditions.

Checking the Pin Depth Gauge

Pin depth gauges should be checked for cleanliness before they are used at a minimum of once per month. Connector cleaning procedures (refer to Section 4-6) can also be used to clean the pin depth gauges.

Pin Depth Dimensions

Before mating, measure the pin depth of the device that will mate with the RF component. The dimensions measured are shown in Figure 4-1.



Index	Description
1	Reference Plane
2	Pin Depth (Inches)
3	Female
4	Male

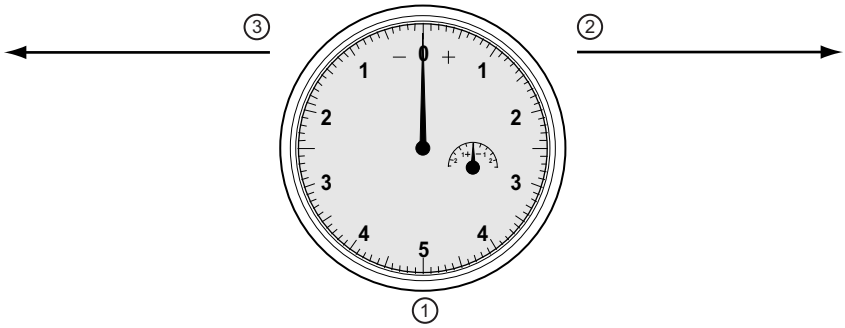
Figure 4-1. N Connector Pin Depth

Pin Depth Gauge

Use an Anritsu Pin Depth Gauge or equivalent as shown in Figure 4-2 on page 4-6 to accurately measure pin depths. Based on RF components returned for repair, destructive pin depth of mating connectors is the major cause of failure in the field.

When an RF component is mated with a connector having a destructive pin depth, damage will likely occur to the RF component connector.

Note	A destructive pin depth has a center pin that is too long in respect to the connector's reference plane.



Index	Description
1	Pin Depth Gauge with needle setting at zero
2	Positive needle direction clockwise to right
3	Negative needle direction counter-clockwise to left

Figure 4-2. Pin Depth Gauge

Pin Depth Tolerances

The center pin of RF component connectors has a precision tolerance measured in "mils" which is equal to 1/1000 inch (0.001") or approximately 0.02540 mm.

Connectors on test devices that mate with RF components may not be precision types and may not have the proper depth. They must be measured before mating to ensure suitability and to avoid connector damage.

When gauging pin depth, if the test device connector measures out of tolerance (see Table 4-2) in the "+" region of the gauge (see Figure 4-2 on page 4-6), the center pin is too long. Mating under this condition will likely damage the termination connector.

On the other hand, if the test device connector measures out of tolerance in the "–" region, the center pin is too short. While this will not cause any damage, it will result in a poor connection and degradation in performance.

Table 4-2. Pin Depth Tolerances and Gauge Settings for USB Power Sensor Connectors

Connector Type	Pin Depth (Inches)	Anritsu Gauge Setting
N Male	+0.003 –0.207 0.000	0.000 –0.207 –0.003
N Female	0.000 –0.207 –0.003	0.000 –0.207 –0.003
K Male	+0.000 –0.003	Same as pin depth
K Female		

4-6 Connector Cleaning

Connector interfaces should be kept clean and free of dirt and other debris. Clean connectors with lint-free cotton swabs. Isopropyl alcohol is the recommended solvent. Figure 4-3 on page 4-8 illustrates the cleaning procedures for male and female connectors.

Note	Most cotton swabs are too large to fit into the ends of the smaller connector types. In these cases it is necessary to peel off most of the cotton and then twist the remaining cotton tight. Be sure that the remaining cotton does not get stuck in the connector.

With continuous use, the outer conductor mating interface will build up a layer of dirt and metal chips that can severely degrade connector electrical and mechanical performance. It can also increase the coupling torque which can damage the mating interface. Cleaning connectors is essential for maintaining good electrical performance so check them for cleanliness before making any measurements (or calibration).

Required Cleaning Items

- Low pressure compressed air (solvent free)
- Lint-free cotton swabs
- Isopropyl alcohol (IPA)
- Microscope

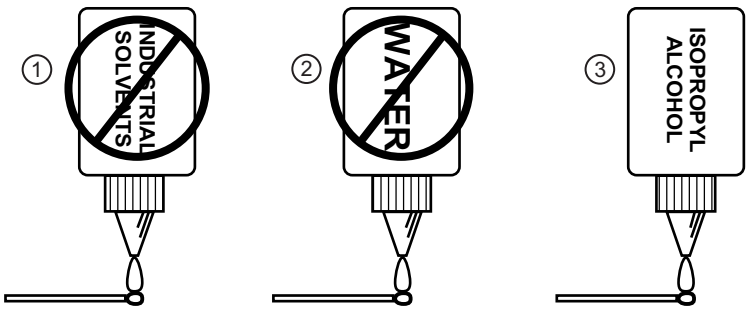
Important Cleaning Tips

Use the following important tips when cleaning connectors:

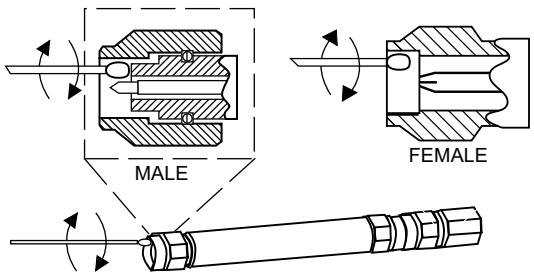
- Use only isopropyl alcohol as a solvent.
- Use only lint-free cotton swabs
- Use an appropriate size of cotton swab.
- Gently move the cotton swab around the center conductor.
- Never put lateral pressure on the connector center pin.
- Verify that no cotton strands or other foreign material remain in the connector after cleaning.
- Only dampen the cotton swab. Do NOT saturate it.
- Compressed air may be used to remove foreign particles and to dry the connector.
- Inspect after cleaning to verify that the center pin has not been bent or damaged.

Cleaning Procedure

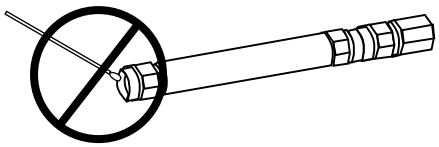
1. Remove loose particles on the mating surfaces, threads, and similar surfaces using low-pressure compressed air.
2. The threads of the connector should be cleaned with a lint-free cotton swab. When connector threads are clean, the connections can be hand-tightened to within approximately one-half turn of the proper torque.
3. Clean mating plane surfaces using alcohol on lint-free cotton swabs (Figure 4-3 on page 4-8).
    - Make sure that the cotton swab is not too large.
    - Use only enough solvent to clean the surface.
    - Use the least possible pressure to avoid damaging connector surfaces.
    - Do not spray solvents directly on to connector surfaces
4. After cleaning with swabs, again use low-pressure compressed air to remove any remaining small particles and to dry the connector surfaces.
5. Inspect the connectors for cotton strands or other debris after cleaning.



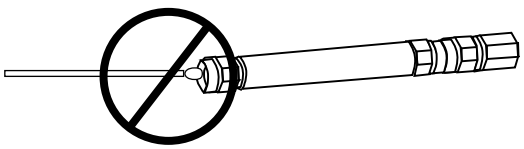
④ Do NOT use Industrial Solvents or Water on connector. Use only Isopropyl Alcohol. Dampen only, DO NOT saturate.



⑤ Use only isopropyl alcohol and the proper size of cotton swab. Gently rotate the swab around the center pin being careful not to stress or bend the pin or you will damage the connector.



⑥ Do NOT put cotton swabs in at an angle, or you will damage the connectors.



⑦ Do NOT use too large of cotton swab, or you will damage the connectors.

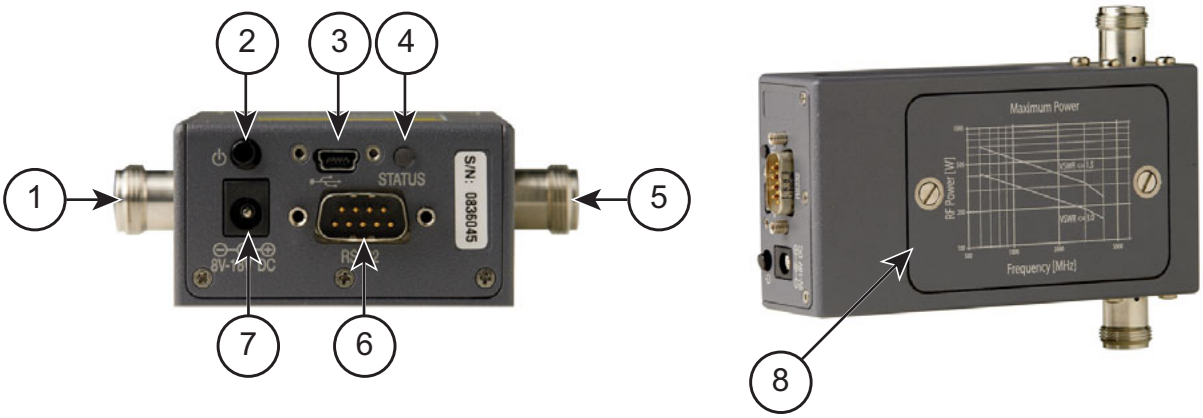
Index	
1	No industrial solvents
2	No Water
3	Use Isopropyl Alcohol
4	Do NOT use Industrial Solvents or Water on connector. Use only Isopropyl Alcohol. Dampen only, Do NOT saturate.
5	Use only isopropyl alcohol and the proper size of cotton swab. Gently rotate the swab around the center pin being careful not to stress or bend the pin or you will damage the connector.
6	Do NOT put cotton swabs in at an angle, or you will damage the connectors.
7	Do NOT use too large of cotton swab, or you will damage the connectors.

Figure 4-3. Connector Cleaning

Chapter 5 — Using the MA24104A

5-1 Sensor Overview

The power sensor's connectors are illustrated in the figure below:



Index	Description
1	RF Input: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
2	Power ON/OFF
3	USB Mini-B Port (for connection with a PC or Anritsu Handheld instrument)
4	2-color LED (reports functional status of the sensor) **Green:** Sensor ON, Status OK **Amber:** Error Condition (see Table 5-5 on page 5-10) **Blinking:** Low Battery
5	RF Output: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
6	RS-232 Port (for connection with Anritsu handheld instruments; requires batteries or external power)
7	DC Input (for RS232 use without batteries)
8	Battery Compartment (supports 3AA size batteries) **Note:** When using battery power with the RS232 interface, the MA24104A enables an auto shutdown (sleep) feature. If the RS232 bus is disconnected or becomes inactive, the power sensor shuts down (sleeps) to preserve battery power. The sensor automatically powers up (wakes up) when the host is reconnected or becomes active. Zeroing is then required before taking measurements.

Figure 5-1. MA24104A Sensor Overview

5-2 Making Measurements

This section presents common procedures for using the MA24104A power sensor with a PC. These procedures refer to the MA24104A sensor and Anritsu PowerXpert PC application buttons and menus that were previously described. Before attempting these procedures, you should be familiar with the Anritsu PowerXpert PC application. If an Anritsu Master™ series handheld instrument is being used with the power sensor, refer to the user documentation that came with the handheld instrument for procedures on operating external power sensors.

Basic Power Measurement

Caution	The supplied USB cable with the screw-in connector should be securely fastened to the sensor to avoid damage to the mini-USB connector.

1. Connect the sensor to a computer or Anritsu Master™ series instrument as shown in Figure 5-2 on page 5-3 and turn the power sensor **ON** by pressing the sensor's power button for 1 second.

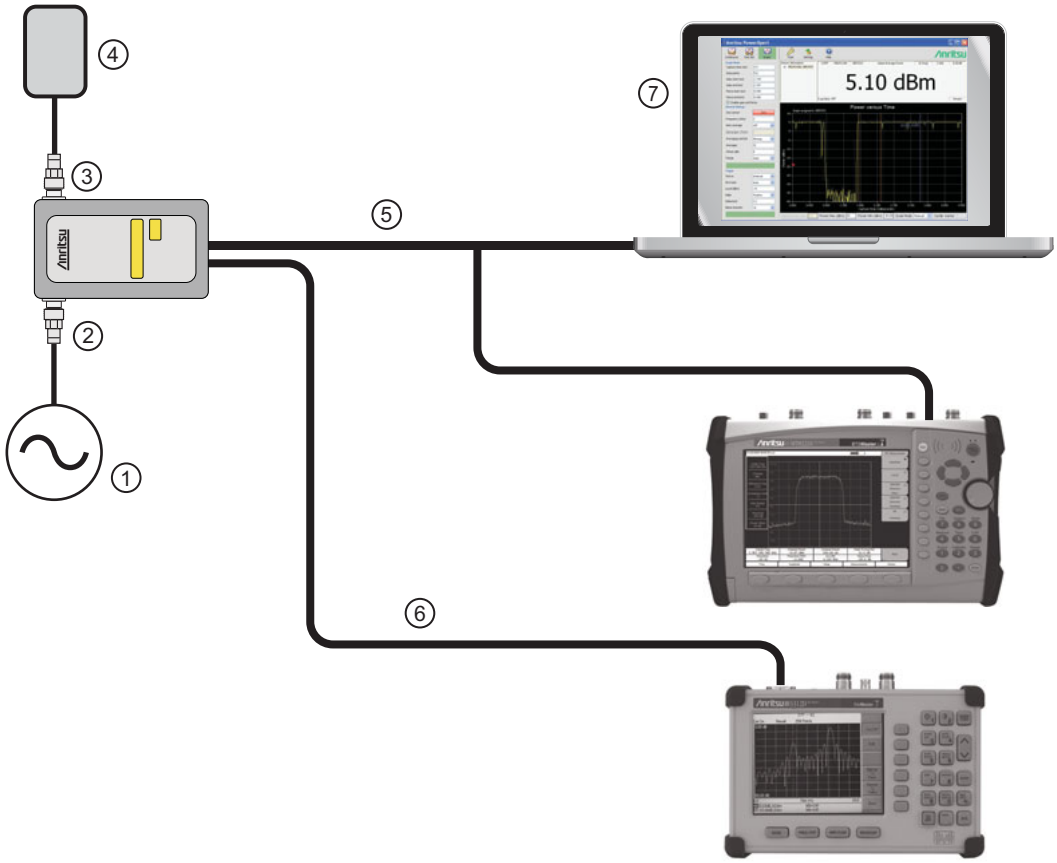
Note	Operation with the RS232 port requires an external power supply or batteries installed in the sensor. A USB connection does not require an external power supply or batteries. When changing connection methods (USB/RS232), the sensor must be powered off and back on, and re-zeroed. If the sensor goes into sleep mode, the sensor must be re-zeroed before taking measurements.

2. Open the Anritsu Power Meter application.
3. Zero the sensor as described below in "Zeroing the Sensor".

Warning	**Do not** connect or apply power outside of the MA24104A specifications or permanent damage may result.

Caution	**Before connecting the power sensor to another device, ensure the following:** Both connectors are in good condition and undamaged Pin depth is verified Both connectors are clean Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor. ESD precautions are observed. Refer to Chapter 4, "Power Sensor Care" for complete details. **When connecting the power sensor, ensure the following:** The connectors are aligned before mating Do not turn the connector body–only the connector coupling nut. Torque the connection using the correct torque wrench and proper torquing technique. Do not over torque. Refer to Chapter 4, "Power Sensor Care" for complete details.

4. Connect the load to the RF OUT port of the sensor. Connecting the load first protects the power sensor as well as the source/DUT from excessive mismatch.
5. Connect the RF source to the RF IN port of the power sensor.
6. Read the power measurement from the Anritsu Power Meter application window (power readings are continuous with the default setting).



Index	Description
1	Source
2	RF In: N type Connector (Torque connector at 12 lbf·in (1.35 N·m)
3	RF Out: N type Connector (Torque connector at 12 lbf·in (1.35 N·m)
4	Load
5	USB to PC or BTS, VNA, or Spectrum Master
6	RS-232 to SiteMaster or Cell Master
7	PC with Anritsu PowerXpert Application

Figure 5-2. Measurement Setup

Connecting the Sensor

RF signal connections are made to the Type N female RF connectors, which have a 50 Ω characteristic impedance. The input port is labeled RF IN and the output port is labeled RF OUT.

Warning	**Do not** connect the sensor backwards (RF IN and RF OUT reversed) or apply power outside of the MA24104A specifications or permanent damage may result.

When connecting to the Type N female connector of the MA24104A to a Type N connector, observe the following proper practice for tightening the connection:

1. While holding the body of the N connector in one hand, turn the Type N Male connector nut to finger tighten the connection. **Do not** turn the body of the MA24104A as this will cause excessive wear to the connector.

2. Back off the connection by turning the connector nut counter clockwise ¼ turn.
3. Tighten the connection (clockwise) using a 12 in-lb torque wrench (Anritsu part number: 01-200).

Note	The Sensor has a USB 2.0 interface with a USB Type Mini-B port. The MA24104A can be remotely programmed over this USB interface. In addition to programming, the MA24104A is powered by the USB. The interface is USB 2.0 compatible, but with an interface speed of 12 Mbps.

Zeroing the Sensor

Zero the sensor before making power measurements. If frequent low-level measurements are being made, it is advised to check the sensor zeroing often and repeat as necessary. If the sensor goes into sleep mode, the sensor must be re-zeroed before taking measurements. Before zeroing the sensor, connect it to the DUT (device under test) test port and remove RF power from the connection to a level 20 dB below the noise floor of the power sensor. For the MA24104A power sensor, this level is less than –20 dBm. It is preferable to leave the sensor connected to the DUT test port so that ground noise and thermal EMF (electro-magnetic fields) are zeroed out of the measurement. The sensor may also be connected to a grounded connector on the DUT or disconnected from any signal source.

To zero the sensor, click the **Zero** button on the application. If the sensor fails the zeroing operation, the message box states “Sensor zero failed” and “ZERO_ERROR” will be displayed on the application screen until the problem is corrected. If RF is detected, a reminder message will pop up asking to remove the RF source.

Calibrating the Sensor

The signal channel/analog signal acquisition hardware is integrated along with the RF front end of the power sensor. All of the necessary frequency and temperature corrections take place within the sensor. Therefore, there is no need for a reference calibration with the MA24104A.

Applying a Calibration Factor Correction

The MA24104A power sensor has an internal EEPROM containing correction and calibration factors that were programmed into the sensor at the factory. The power sensor has an internal temperature sensor that reports its readings periodically to the microprocessor. The sensor makes all of the required calculations on the measurement once the measurement frequency has been entered by the user.

Optimizing the Readings

This section presents information on how to get the fastest readings from the MA24104A power sensor when using the Anritsu Power Meter application or operating under remote control (refer to Chapter 13 for specific remote programming command descriptions). Measurement speed depends greatly on the type of measurement, the power level, and stability of the signal. Stability of a measurement is influenced by noise and signal modulation. If high resolution is required, averaging must be increased.

Note	The values in the following tables are typical and should be used as a reference only.

Table 5-1 describes the number of averages needed to attain a certain noise level for a particular power level measurement with the Low Aperture Time mode setting.

Table 5-1. MA24104A Averaging Table (Low Aperture Time, Default Mode)

Input Power (dBm)	Input Power (W)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
50	100	1	1	1	1	2
45	31.6	1	1	1	4	16
40	10.0	1	1	1	20	78
35	3.16	1	1	1	1	1
30	1.00	1	1	1	1	1
25	0.316	1	1	1	1	7
20	0.100	1	1	1	3	61
15	0.0316	2	3	7	25	–
10	0.0100	16	28	62	245	–
5	0.00316	158	–	–	–	–

Table 5-2, describes the number of averages needed to attain a certain noise level for a particular power level measurement with the High Aperture Time mode setting.

Table 5-2. MA24104A Averaging Table (High Aperture Time)

Input Power (dBm)	Input Power (W)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
50	100	1	1	1	1	1
45	31.6	1	1	1	1	1
40	10.0	1	1	1	2	5
35	3.16	1	1	1	1	1
30	1.00	1	1	1	1	1
25	0.316	1	1	1	1	1
20	0.100	1	1	1	1	4
15	0.0316	1	1	1	2	38
10	0.0100	1	2	4	16	–
5	0.00316	10	18	39	153	–

5-3 Measurement Considerations

Time Varying Signals

Case 1: Modulated signals with pulse or pattern repetition times ≤ 1 ms (PRF ≥ 1 KHz)

If you obtain a steady power reading of a modulated signal (no significant fluctuations of the displayed power) with no averaging, then it is likely that the pulse or pattern repetition rate is greater than 1 KHz. In this case, most of the averaging of the envelope power is performed in the front end of the sensor (before being digitized). When this is the case, the MA24104A will provide an accurate indication of the average power with no special considerations.

Case 2: Modulated signals with pulse or pattern repetition times between 1 ms and 50 ms (100 Hz < PRF < 1 KHz)

In this case, the signal is varying too slowly to be averaged in the front end of the sensor, so averaging must be performed after digitalization by increasing the averaging number in the power meter application (or calculating the average of several measurements if controlling the sensor over the bus). A large amount of averaging must be used for some pulse/pattern repetition frequencies to get a steady reading. If Low Aperture Time (LAT) mode is selected, the maximum recommended pulse repetition time is about 10 ms. If High Aperture Time (HAT) mode is selected, signals with pulse repetition periods as long as 50 ms can usually be measured.

Case 3: Modulated signals with pulse or pattern repetition times greater than 50 ms

In this case, it can be difficult to get an accurate average power reading even by averaging many readings. The sample rate of the sensor and the pulse repetition rate of the signal may be close enough that they can “beat” together resulting in low frequency modulation of the power indication. If averages are not calculated over many of these beats, or an integer number of beats, errors can result. This is not unique to the MA24104A and can be an issue with any power sensor/meter and any sampled data system.

Multitone Signals

The MA24104A is a True-RMS sensor that can measure very wide bandwidth modulation. The only limitation is the frequency flatness of the sensor. Because the sensor’s sensitivity is not identical for all frequencies and when measuring multitone signals, the frequency entered into the sensor’s application should be the average frequency of all significant tones. The MA24104A has an error of 0.1 dB for every 100 MHz bandwidth at frequencies between 1 GHz and 3 GHz, and an error of 0.5 dB for every 100 MHz bandwidth at frequencies below 1 GHz and above 3 GHz.

Noise and Averaging

When there is a need to achieve a required reading resolution, particularly at low power levels, averaging is often needed to reduce noise and steady the displayed power reading. Use the noise vs. resolution tables (Table 5-1 and Table 5-2 on page 5-5) to determine the number of averages that will typically be required for a given resolution. Alternatively, determine the number of averages through calculation by using the noise specifications and the fact that noise will be proportional to the square root of N, where N is the number of averages.

For example, a CW tone at +40 dBm is to be measured to 0.01 dB resolution. Using Table 5-1 and Table 5-2 on page 5-5, the required number of averages is 5 averages using High Aperture Time mode (the same measurement would require more than 78 averages in Low Aperture Time mode).

Settling Time

The MA24104A samples power continuously every 70 ms in the Low Aperture Time (LAT) mode and 700 ms in the High Aperture Time (HAT) mode. The sensor's front end and digitizer settles completely to a step change in power in this amount of time. However, there is no way to synchronize the sensor's sampling to any other event, such as a power step or bus request for a measurement. Therefore, the first measurement requested from the sensor after a power step may not be fully settled. To ensure a fully settled measurement when operating the sensor over the bus, wait 70 ms (700 ms if in HAT) after a power step before requesting the measurement from the sensor. Alternatively, request two measurements from the sensor and discard the first.

If averaging is required as described above, settling time increases by N × sample period, where N is the number of averages and the sample period is the time in milliseconds. The measurement sample period is 70 ms for LAT and 700 ms for HAT. When operating the sensor over the bus, request N+1 measurements from the sensor, discard the first, and then average the subsequent readings. The settling time is approximately (N+1) × sample period.

Maximum Power

The MA24104A is rated to meet all specifications up to an average input power level of 150 Watts. See Figure 5-3. Although the average power of all signals should be kept at or below this level, time varying and burst signals having peak powers less than the limits shown in the figure below can be measured. To ensure accurate readings, the peak-to-average ratio (crest factor) of signals must be less than 12 dB.

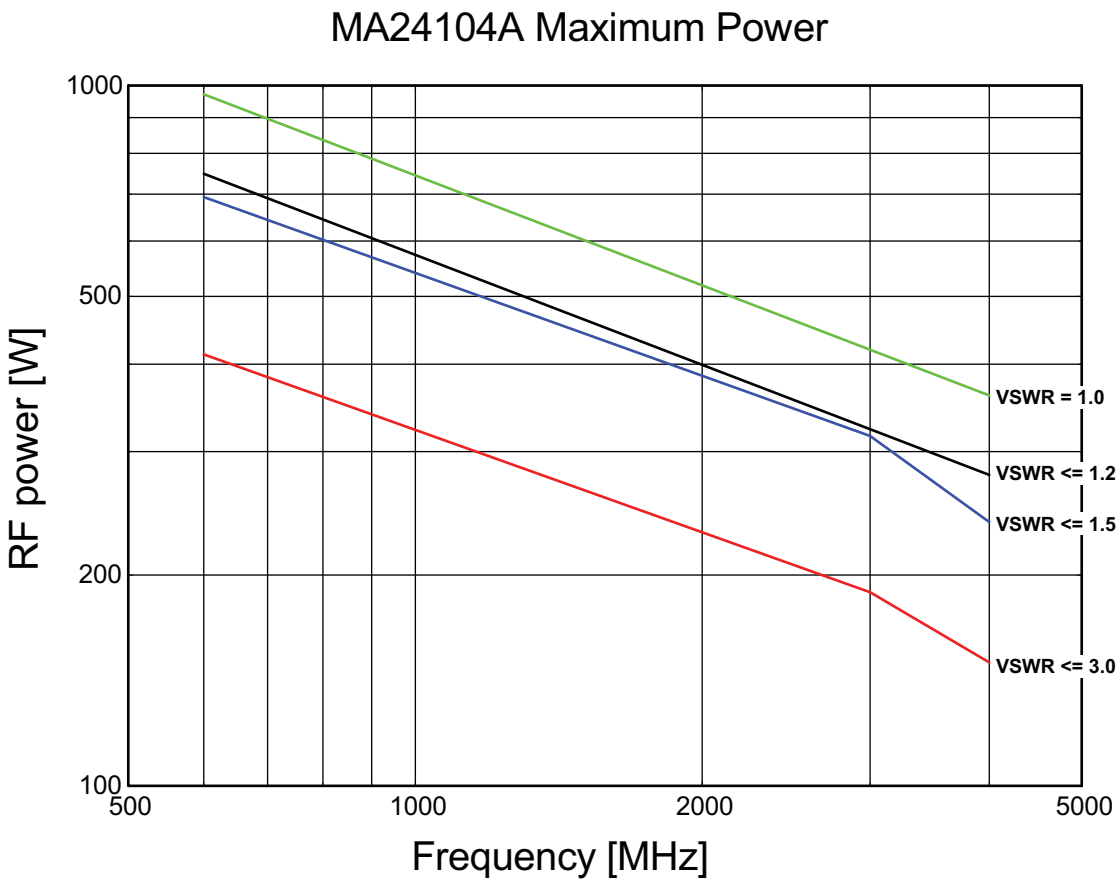


Figure 5-3. Maximum Power Handling Capacity

5-4 Uncertainty of a Measurement

Measurement Uncertainty Calculator

Included on the Power Expert CD-Rom is a Microsoft Excel tool for calculating power uncertainty. It is accessible from the Startup.htm page. It contains two tabs; one that provides measurement uncertainty for each sensor (selectable from a drop-down menu), and another tab that provides additional uncertainty components and calculated values for the MA24105A Peak Power Sensor.

Uncertainty Components

Power measurements have many component parts that affect overall measurement uncertainty when measuring power with the MA24104A sensor:

- **Measurement Uncertainty:** Measurement uncertainty includes the uncertainty associated with the correction of frequency and the linearity response of the sensor over the entire dynamic range. Anritsu follows the industry standard condition of calibrating the power-sensing element at a reference power of 0 dBm (1 mW) and an ambient temperature of 25° C.
- **Temperature Compensation:** Sensor Temperature Compensation describes the relative power level response over the dynamic range of the sensor. Temperature Compensation should be considered when operating the sensor at other than room temperature.
- **Noise, Zero Set, and Zero Drift:** These are factors within the sensor that impact measurement accuracy at the bottom of the power sensor's dynamic range.
- **Mismatch Uncertainty:** Mismatch uncertainty is typically the largest component of measurement uncertainty. The error is caused by the differing impedances between the power sensor and the devices to which the power sensor is connected. Mismatch uncertainty can be calculated as follows:
  - **Source Mismatch:**

    % Source Mismatch Uncertainty = $100[|1 + \Gamma_1\Gamma_2|^2 - 1]$

    dB Mismatch Uncertainty = $20\log|1 + \Gamma_1\Gamma_2|$
  - **Load Mismatch (not considering inline power sensor insertion loss):**

    % Load Mismatch Uncertainty = $100[|1 + \Gamma_2\Gamma_3|^2 - 1]$

    dB Load Mismatch Uncertainty = $20\log|1 + \Gamma_2\Gamma_3|$
  - **Load Mismatch (considering inline power sensor insertion loss):**

    % Load Mismatch Uncertainty = $100[|1 + \mathbf{t}^2\Gamma_2\Gamma_3|^2 - 1]$

    dB Load Mismatch Uncertainty = $20\log|1 + \mathbf{t}^2\Gamma_2\Gamma_3|$
- **Directivity Uncertainty:**

  % Uncertainty due to Finite Directivity = $100[(1 + \Gamma_3 / \mathbf{D})^2 - 1]$

where:

D is the directivity of the inline power sensor expressed in linear units

Γ_1 is the reflection coefficient of the inline power sensor

Γ_2 is the reflection coefficient of the source

Γ_3 is the reflection coefficient of the load

t is the inline power sensor's transmission coefficient

$\mathbf{t} = 10^{(IL/20)}$

IL = Insertion Loss of the inline power sensor

Uncertainty Examples

Two measurement uncertainty calculations for Low Aperture Time mode are shown for the MA24104A in Table 5-3. The MA24104A is used to measure the power of a 1 GHz, +50.0 dBm and +10 dBm CW signal from a signal source with a 1.5:1 VSWR and a load having a 1.2:1 VSWR. The example is based on 128 measurement averages.

Table 5-3. Measurement Uncertainty Examples

Uncertainty Term	Uncertainty at +50 dBm (%)	Uncertainty at +10 dBm (%)	Probability Distribution	Divisor	Adjusted Uncertainty at +50 dBm (%)	Adjusted Uncertainty at +10 dBm (%)
Measurement Uncertainty	3.8	3.8	Normal at 2σ	2	1.9	1.9
Noise	0.0	1.0	Normal at 2σ	2	0.0	0.5
Zero Set	0.1	4.0	Rectangular	√3	0.0	2.3
Zero Drift	0.0	1.2	Normal at 2σ	2	0.0	0.7
Directivity Induced Uncertainty	0.6	0.6	Rectangular	√3	0.3	0.3
Source Mismatch Uncertainty	1.4	1.4	Rectangular	√3	0.8	0.8
Load Mismatch Uncertainty	3.7	3.7	Rectangular	√3	2.1	2.1
Effect of Digital Modulation	0	0	Rectangular	√3	0	0
Combined Uncertainty (RSS) Room Temperature					3.0	3.9
Expanded Uncertainty with K=2 Room Temperature					6.0	7.7
Temperature Compensation	1.4	1.4	Rectangular	√3	0.8	0.8
Combined Uncertainty (RSS, 0 to 50 °C)					3.1	3.9
Expanded Uncertainty with K=2 (RSS, 0 to 50 °C)					6.2	7.9

Table 5-4. Noise Measurement Uncertainty Calculations

Noise Calculations at 50 dBm (100 W):	
Noise	24 mW/100 W = 0.0 %
Zero Set	68 mW/100 W = 0.1 %
Zero Drift	20 mW/100 W = 0.0 %
Noise Calculations at +10 dBm (10 mW):	
Noise	100 μW/10 mW = 1.0 %
Zero Set	398 μW/10 mW = 4.0 %
Zero Drift	119 μW/10 mW = 1.2 %

5-5 Error States

This section details some of the error messages that may appear on the application screen. In most cases, the error condition can be easily corrected. The status LED will light amber when an error state occurs. If not, note the error message and contact an Anritsu Service Center.

Table 5-5. Error Messages

Message	Description	Resolution
Zero invalid as temperature changed by more than 10 Degrees C	The sensor's ambient temperature has changed by more than 10 ºC since the last zero operation.	Perform the zero operation again.
Temperature out of operating range	The sensor is operating outside of its specified range of 0 ºC to 55 ºC.	Operate the sensor within its specified range.
Sensor zero failed	This message box appears if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ZERO_ERROR	This message appears on the application screen if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ADC_TEMP_OVERRNGE	This message appears on the application screen if the sensor is being operated in extremely high temperatures and has overheated.	Remove the sensor from the USB connection and allow to cool to the operating range of the sensor: 0 ºC to 55 ºC

Chapter 6 — Operational Testing for the MA24104A

6-1 Introduction

The test methodology and equipment described here can be used to gain some confidence in the measurement accuracy of the MA24104A Power Sensor. This is accomplished by comparing the sensor to another sensor with a specified cal factor and linearity performance or uncertainty. General commercially available equipment is used for these tests; however, these procedures are not sufficiently accurate to verify sensors to factory specification. Therefore, sensor test limits in these procedures are set appropriately to the specified comparison equipment. All tests should be performed at an ambient temperature of 20 ºC to 25 ºC.

Note	Calibration and verification of high accuracy power sensors requires substantial investment in both skill and equipment. For calibration, calibration verification, and to maintain the factory specifications of your power sensor, please send sensors to a qualified Anritsu Customer Service Center.

Refer to the following sections for required equipment and test procedures:

- “Required Equipment - MA24104A”
- “VSWR Pretest”
- “Directivity Test”
- “Frequency Response Test”
- “Linearity Test”

6-2 Precautions

Warning	**Do not** connect or apply power outside of the power sensor specifications or permanent damage may result.

Caution	**Before connecting the power sensor to another device, ensure the following:** Both connectors are in good condition and undamaged Pin depth is verified Both connectors are clean Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor. ESD precautions are observed. Refer to Chapter 4, “Power Sensor Care” for complete details. **When connecting the power sensor, ensure the following:** The connectors are aligned before mating Do not turn the connector body–only the connector coupling nut. Torque the connection using the correct torque wrench and proper torquing technique. Do not over torque. Refer to Chapter 4, “Power Sensor Care” for complete details.

6-3 Required Equipment - MA24104A

Table 6-1. Required Equipment

Equipment Description	Manufacturer and Model	Critical Specifications
Vector Network Analyzer (Pretest)	Anritsu MS4642A or equivalent	Reflection Coefficient Uncertainty ≤ 0.013, 600 MHz to 2 GHz Uncertainty ≤ 0.020, 2 GHz to 4 GHz
Synthesizer (Cal. Factor and Linearity Tests)	Anritsu MG3692B or equivalent	Output Power: ≥ +20 dBm 0.05 GHz to 4 GHz Output Power Setting Resolution: 0.01 dBm Harmonics: ≤ –40 dBc Source VSWR ≤ 2.00
Reference Power Meter (Cal. Factor and Linearity Tests)	Anritsu ML2438A or equivalent	Instrumentation Accuracy ≤ 0.5 %
Reference Power Sensor (Cal. Factor and Linearity Tests)	Anritsu MA24002A or equivalent	NIST Calibration or equivalent
10 dB N Attenuator (Linearity Test)	Aeroflex Model 1433	VSWR ≤ 1.15, 600 MHz to 4 GHz, 250 W min.
10 dB K Attenuator (Frequency Response and Linearity Tests)	Anritsu 41KC-10	VSWR ≤ 1.15, 600 MHz to 4 GHz, 2 W min.
Low Power 30 dB N Attenuator (Linearity Tests)	42N50A-30	VSWR ≤ 1.2, 600 MHz to 4 GHz, 30 W min.
50 ohm Termination	Aeroflex Model 1433	VSWR ≤ 1.15, 600 MHz to 4 GHz, 250 W min.
Adapter N(f) to K(f) (Frequency Response and Linearity Tests)	Anritsu 34ANF50, 34AS50, 34AN50, and 34ASF50	VSWR ≤ 1.05, 600 MHz to 4 GHz
Power Coupler (Linearity Test)	MITEQ CD2-522-30N	600 MHz to 4.0 GHz, Coupling = 30 dB, 250 W min.
Amplifier (Directivity, Frequency Response and Linearity Tests)	Ophir 5163, 5125	600 MHz to 4.0 GHz, 250 W min. Harmonics < –20 dBc Spurious < –20 dBc
Personal Computer	Any	See Chapter 2

6-4 VSWR Pretest

Excessive mechanical shock can cause a failure in the MA24104A. Excessive shock may cause permanent internal mechanical displacements that results in impedance change. Input match will be degraded when the coupling element impedance is changed. If you suspect that a sensor is damaged, you should start with an input match pretest.

The maximum VSWR values are listed in the Performance Specification section of this manual. The uncertainty of the VSWR test equipment will affect actual measurement values. Table 6-2 shows how measurement system uncertainty can affect the Expected Maximum Reflection Coefficient when using the Anritsu MS4642A Vector Network Analyzer.

Test Procedure

Follow the manufacturers S_{11} (or return loss) calibration procedure to perform calibration on a network analyzer. Connect the power sensor to the network analyzer test port and measure power sensor input match. Typically, matches are measured in terms of return loss in dB. Return loss and magnitude of the reflection coefficient conversion equations are as follows:

$$\rho = 10^{-RL/20}$$

$$RL = -20\log\rho$$

where

RL = Return Loss in dB

ρ = Magnitude of the Reflection Coefficient

VSWR and magnitude of the reflection coefficient conversion equations are as follows:

$$VSWR = (1 + \rho) / (1 - \rho)$$

$$\rho = (VSWR - 1) / (VSWR + 1)$$

where

VSWR = Voltage Standing Wave Ratio

ρ = Magnitude of the Reflection Coefficient

Record the measured data to Table 6-2 in the Actual Measurement column. The Actual Measurement should be smaller than the Maximum Reflection coefficient. The Maximum Reflection Coefficient is the measurement system uncertainty added to the sensor's reflection coefficient specification. If the Actual Measurement reflection coefficient is larger than the Maximum Reflection Coefficient, then the power sensor may be defective. If the actual reflection coefficient is significantly larger than the maximum values in Table 6-2, then the sensor is damaged and it is not necessary to perform further testing.

Note	There are no user-serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return defective sensors with a detailed description of the observed problem.

Table 6-2. Pretest Measurement Result

Frequency	MS4642A Reflection Coefficient Uncertainty	Maximum Reflection Coefficient	Actual Measurement
600 MHz to 3 GHz	0.013	0.033 + 0.013 = 0.046	
3 GHz to 4 GHz	0.020	0.047 + 0.020 = 0.067	

6-5 Directivity Test

The most common cause of power sensor failure is excess input power. Applying power that exceeds the damage level shown on the label will damage MA24104A's coupling element resulting in directivity change. Excessive mechanical shock can also cause directivity to change.

Test Procedure

Directivity tests an MA24104A for how selective the sensor is when measuring power in a given direction of travel and rejecting signals traveling in the opposite direction. The simplified equations below give the first order approximation of this parameter:

Directivity (dB) = Power Forward (dB) – Power Reverse (dB)

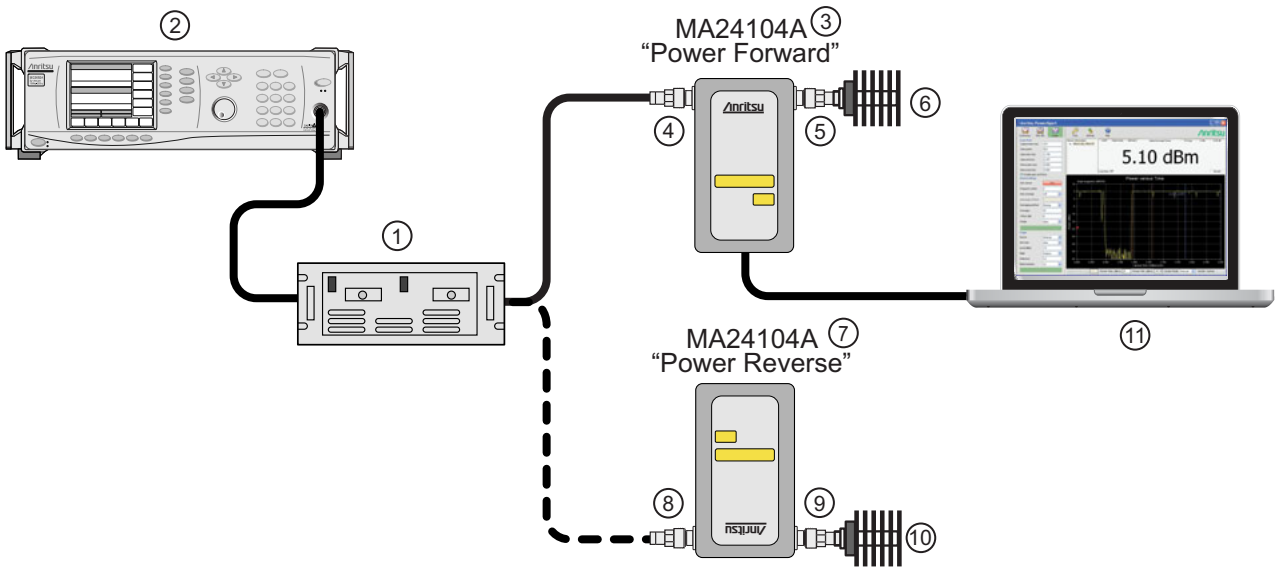
Directivity Coefficient = $10^{(-\text{Directivity (dB)} / 20)}$

Directivity (dB) = $-20 \times \log$(Directivity Coefficient)

Directivity (dB) = $10 \times \log$(Power Forward / Power Reverse), where power is in watts.

In this test, the MA24104A is tested first with power in the forward direction and then with power in the reverse direction. The ratio of the two power readings are the directivity of the device assuming that both the termination and source are perfect 50 ohm matches. Since the termination and source are not perfect matches, residual effects from multiple reflections need to be accounted for by performing the following procedure.

1. Turn off the RF of the synthesizer. Connect the power amplifier to the synthesizer. Connect the output of the amplifier to the input of the MA24104A. Terminate the output of the MA24104A with the specified termination (Figure 6-1).
2. With the RF off, zero the MA24104A.
3. Set the synthesizer to the first frequency in Table 6-3 on page 6-5 and to a very low power setting and slowly increase the power until the MA24104A displays +30 dBm. Allow the devices to warm up for 30 minutes.
4. Turn off the RF of the synthesizer and zero the MA24104A again.
5. Turn on the RF and adjust the synthesizer until the MA24104A displays approximately +44 dBm. Confirm that the reading is stable and record this value as Power Forward in Table 6-3.
6. Turn off the RF on the synthesizer.
7. Reverse the MA24104A connections to the termination and the amplifier. Confirm that the MA24104A output is now connected to the amplifier and that the input is connected to the termination (Figure 6-1).
8. Turn on the RF. Change the MA24104A averages if necessary to see a steady reading. Record the value as Power Reverse in Table 6-3.
9. Calculate the Actual Directivity in dB by subtracting Power Reverse from Power Forward. If the power is in watts, use the formula noted above to calculate the Actual Directivity in dB.
10. If the actual directivity is larger than the minimum allowable directivity in Table 6-3, contact Anritsu customer service.
11. Repeat the steps above for the next frequency in Table 6-3.



Index	Description
1	Amplifier
2	Synthesizer
3	MA24104A "Power Forward" Measurement
4	RF In: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
5	RF Out: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
6	50 ohm Termination
7	MA24104A "Power Reverse" Measurement
8	RF Out
9	RF In
10	50 ohm Termination
11	PC with Anritsu PowerXpert Application

Figure 6-1. Directivity Test Set Up for Power Forward and Power Reverse

Table 6-3. Directivity Test Measured Results

Frequency (GHz)	Reflective Coefficient of Termination	Maximum Directivity Coefficient	A Power Forward (dB)	B Power Reverse (dB)	A – B Actual Directivity (dB)	Minimum Allowable Directivity (dB)
0.6	0.048	0.079				22.0
1.0	0.048	0.079				22.0
1.5	0.048	0.079				22.0
2.0	0.048	0.079				22.0
2.5	0.048	0.101				19.9
3.0	0.048	0.101				19.9
3.5	0.048	0.120				18.4
4.0	0.048	0.120				18.4

6-6 Frequency Response Test

In this test the frequency response of the sensor is tested at one low power level against a reference sensor of known measurement uncertainty. The reference sensor should be calibrated by a reputable standards laboratory using instruments with low published measurement uncertainty values. To perform the comparison, both sensors are used to measure the output power of a synthesizer with a high quality attenuator, such as the 41KC-10 (with appropriate adapters), on the output. The attenuator improves the source match of the synthesizer by lowering the mismatch ripples, thereby lowering the uncertainty in the comparison.

Test Procedure

1. Set up the equipment as follows (refer to Figure 6-2 for an illustration):

a. Connect the reference power sensor to the reference power meter using the appropriate cables.

b. Connect the USB cable between the personal computer with the PowerXpert application installed and the MA24104A power sensor under test.

c. Launch the PowerXpert application.

d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in their respective manuals.

e. Reset or Preset all of the instruments.

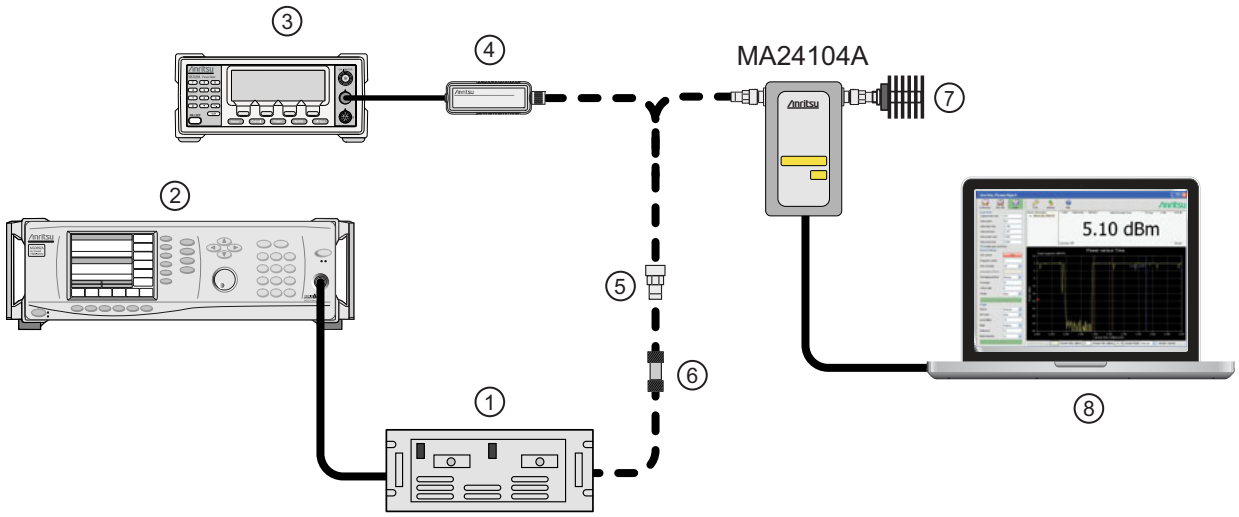
f. Configure the reference meter and sensor to measure a CW signal.

g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

h. Perform a low-level Zero of the MA24104A by disconnecting the MA24104A from the synthesizer, clicking the **Zero** button on the PowerXpert application, and waiting for the Zeroing message to close.

i. Connect the synthesizer to the amplifier input. Connect the attenuator to the amplifier output, then connect the appropriate adapter to the output of the attenuator.

j. Set the synthesizer to 50 MHz and a very low power output.



Index	Description
1	Amplifier
2	Synthesizer

Figure 6-2. Frequency Response Test Set Up (1 of 2)

3	Reference Power Meter
4	Reference Power Sensor
5	K to N Adapter
6	Attenuator
7	50 ohm Termination
8	PC with Anritsu PowerXpert Application

Figure 6-2. Frequency Response Test Set Up (2 of 2)

2. Connect the reference sensor to the amplifier with the appropriate adapter and attenuator in-line (see Figure 6-2).
3. Apply the Cal factor to the reference sensor per the manufacturer's instruction.
4. Adjust the synthesizer power until the reference displays +15 dBm.
5. Record the power indicated by the reference meter in Table 6-4.
6. Disconnect the reference sensor from the synthesizer output and connect the MA24104A power sensor with the appropriate adapter and attenuator in-line (see Figure 6-2).
7. Apply the Cal factor to the MA24104A by entering the frequency (in GHz) in the PowerXpert application, and then click **Apply above settings**.
8. Record the power indicated by the MA24104A in Table 6-4.
9. Set the synthesizer frequency to the next frequency in Table 6-4.
10. Repeat Step 2 through Step 9 until all of the frequencies in Table 6-4 have been measured.
11. For each row in Table 6-4, calculate the absolute value of the difference between the recorded Reference power measurement and the recorded MA24104A measurement, and record the result in Table 6-4.
12. For each frequency, compare the power difference to the maximum allowed difference specified in Table 6-4. If the difference is higher than the maximum allowed difference, contact Anritsu customer service.

Table 6-4. Test Measurement Results

Frequency (GHz)	A Reference Power Measurement (dBm)	B MA24104A Measurement (dBm)	|A-B| Absolute Value of Difference in Power Measurements (dB)	Maximum Allowed Difference (dB)
0.6				0.33
1.0				0.33
1.5				0.33
2.0				0.33
2.5				0.36
3.0				0.36
3.5				0.37
4.0				0.37

6-7 Linearity Test

The linearity correction of the MA24104A is compared to a thermal power sensor, which has very good inherent linearity over a power range of about –20 to +10 dBm. For this reason, the MA24104A will be compared to the thermal sensor in two *ranges*, keeping the power levels to the thermal sensor in the range of –17 dBm to +5 dBm, while the power to the MA24104A will vary from about –26 dBm to about +14 dBm.

Test Procedure

1. Set up the equipment as follows (see Figure 6-3):

a. Connect the reference power sensor to the reference power meter using the appropriate cables.

b. Connect the USB cable between the personal computer with the PowerXpert application installed and the MA24104A power sensor under test.

c. Launch the PowerXpert application.

d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in the instrument's respective manuals.

e. Reset or Preset all of the instruments.

f. Configure the reference meter and sensor to measure a CW signal.

g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

h. Perform a low-level Zero of the MA24104A by disconnecting the sensor from the synthesizer, click the **Zero** button in the PowerXpert application, and wait for the Zeroing message to close.

i. Connect the power coupler to the output of the synthesizer and connect the 10 dB K attenuator using an adapter to the coupler's coupling output.

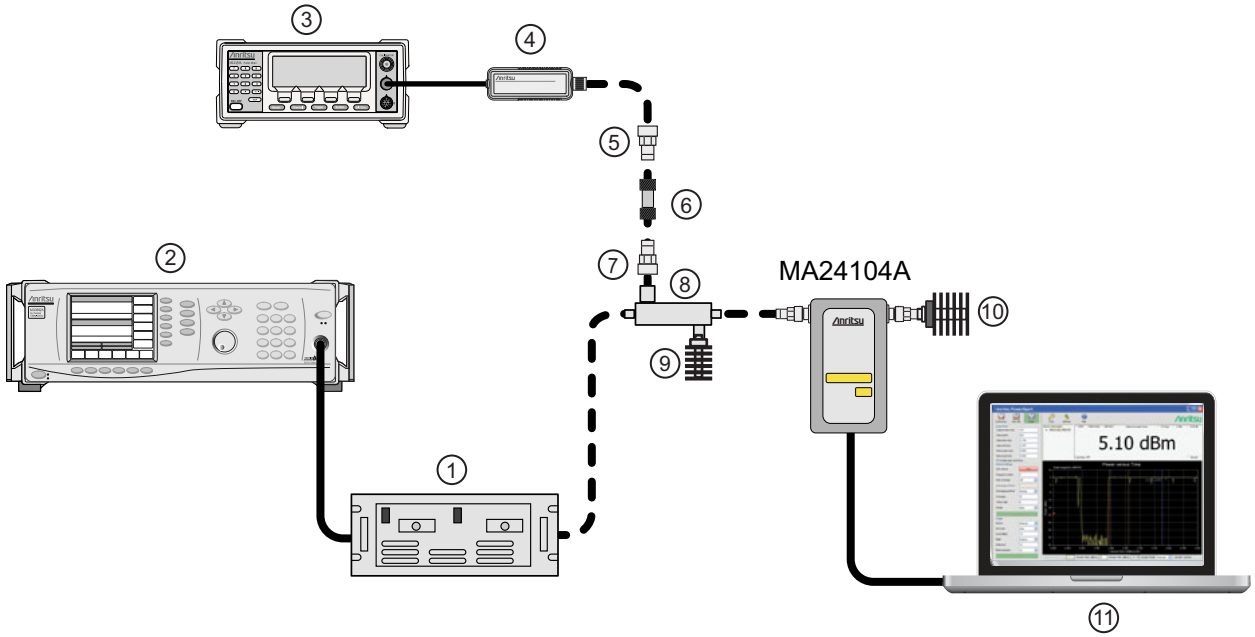
j. Connect the low power 30 dB N attenuator to the other coupling output.

k. Connect the reference sensor to the 10 dB K attenuator using an adapter.

l. Connect the MA24104A to the output of the coupler.

m. Set the synthesizer to 50 MHz and a very low power level.

n. Increase averaging by entering "16" in the PowerXpert application, and then click **Apply above settings**.



Index	Description
1	Amplifier
2	Synthesizer
3	Reference Power Meter
4	Reference Power Sensor
5	K to N Adapter
6	10 dB K Attenuator
7	K to N Adapter
8	Power Coupler
9	30 dB N Attenuator
10	50 ohm Termination
11	PC with Anritsu PowerXpert Application

Figure 6-3. Linearity Test Setup 1

2. Apply the Cal factor to the reference sensor per the manufacturer's procedure.

3. Apply the Cal factor to the MA24104A by entering the frequency (in GHz) in the PowerXpert application, and then click **Apply above settings**.

4. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24104A.

5. Turn On the synthesizer's RF output.

6. Adjust the synthesizer's power until the MA24104A is reading approximately +45 dBm.

7. Record data for the first 20 dB range as follows:

a. Record the power reading by the reference meter in Table 6-5 on page 6-11.

b. Record the power reading by the MA24104A in Table 6-5.

c. Reduce synthesizer power by 5 dB. The Amplifier output and the MA24104A should be about +40 dBm.

d. Record the reference meter and the MA24104A power sensor readings in Table 6-5.

e. Repeat the measurement for amplifier output levels of +35, +30, and +25 dBm.

Note	The MA24104A power measured at +25 dBm will be used in Step 8e, below.

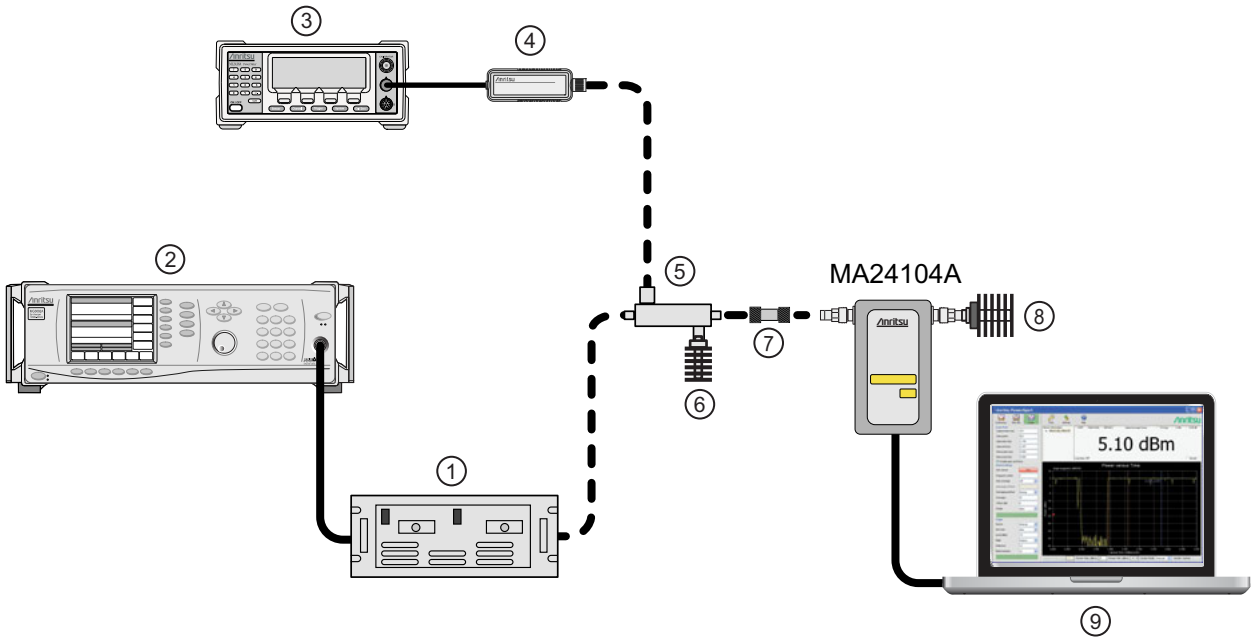
8. Set up the test for the second 20 dB range as follows:

a. Remove the 10 dB K attenuator from in between the reference sensor and coupler, then connect the reference sensor directly to the coupler's coupling port.

b. Remove the MA24104A from the coupler and connect the 10 dB N attenuator between the coupler and the MA24104A power sensor (see Figure 6-4).

c. Turn off the synthesizer RF output and perform a low-level Zero of both the Reference sensor and the MA24104A.

d. Turn on the synthesizer RF output.



Index	Description
1	Amplifier
2	Synthesizer
3	Reference Power Meter
4	Reference Power Sensor
5	Power Coupler
6	30 dB N Attenuator
7	10 dB N Attenuator
8	50 ohm Termination
9	PC with Anritsu PowerXpert Application

Figure 6-4. Linearity Test Setup 2

e. Set the amplifier output level to approximately 5 dB higher and then adjust the output level until the MA24104A reads as close as possible to the value obtained in Step 7e.

9. Record data for the next 20 dB range:

a. Read and record the power indicated by the reference meter in Table 6-5.

b. Lower the output power level of the amplifier by 5 dB. The amplifier output should be about +30 dBm and the MA24104A should be about +20 dBm.

c. Record the reference meter and the MA24104A power sensor readings in Table 6-5.

d. Repeat the measurement for amplifier output levels of +25, +20, and +15 dBm.

Table 6-5. Measurement Results (50 MHz)

Row #	Approx. Output Power of the Amplifier (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6 – A5) Correction (dB)	C = (A + B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24104A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	45	10				0		
2	40	10				0		
3	35	10				0		
4	30	10				0		
5	25	10				0		
6	adjust per Step 8e	0		0		10		
7	30	0		0		10		
8	25	0		0		10		
9	20	0		0		10		
10	15	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

10. Perform the calculations and operational check as follows:

a. Subtract the Reference Power Measurement of row 5 from the Reference Power Measurement of row 6. Record this value in the Correction column of rows 1 through 5.

Note	The Correction column of rows 1 through 5 should all have the same value. The Correction column of rows 6 through 10 have values of 0.

b. Add the Reference Power Measurement and Correction values of row 1 and record the result in the Corrected Reference Power Measurement column of row 1.

c. Repeat Step 10b for rows 2 through 10.

d. Subtract the MA24104A Measurement of row 1 from the Corrected Reference Power Measurement of row 1 and record the result in the Difference Calculation column of row 1.

e. Repeat Step 10d for rows 2 through 10.

f. Find the largest (most positive) value in the Difference Calculation column and record this value next to the word Max in row 11.

g. Find the smallest (least positive or most negative) value in the Difference Calculation column and record this value next to the word Min in row 12.

h. Subtract the Min value from Step 10g from the Max value from Step 10f and record the result next to the word Delta in row 13.

i. The Delta result should be less than 0.3 dB. If it is larger, contact Anritsu customer service.

11. Repeat the entire measurement and calculations with synthesizer frequency settings of 2 GHz and 4 GHz.

Table 6-6. Measurement Results (2 GHz)

Row #	Approx. Output Power of the Amplifier (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24104A Measurement (dBm)	C–D Difference Calculation (dB)
1	45	10				0		
2	40	10				0		
3	35	10				0		
4	30	10				0		
5	25	10				0		
6	adjust per Step 8e	0		0		10		
7	30	0		0		10		
8	25	0		0		10		
9	20	0		0		10		
10	15	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 6-7. Measurement Results (4 GHz)

Row #	Approx. Output Power of the Amplifier (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24104A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	45	10				0		
2	40	10				0		
3	35	10				0		
4	30	10				0		
5	25	10				0		
6	adjust per Step 8e	0		0		10		
7	30	0		0		10		
8	25	0		0		10		
9	20	0		0		10		
10	15	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Chapter 7 — Using the MA24105A

7-1 Sensor Overview

The power sensor's connectors are illustrated in the figure below:

Index	Description
1	RF Input: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
2	RF Output: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
3	USB Micro-B Port (for connection with a PC or Anritsu Handheld instrument)
4	2-color LED (reports functional status of the sensor) **Green:** Sensor ON, Status OK **Amber:** Error Condition (see Table 7-6 on page 7-10)

Figure 7-1. MA24105A Sensor Overview

7-2 Making Measurements

This section presents common procedures for using the MA24105A power sensor with a PC. These procedures refer to the MA24105A sensor and Anritsu PowerXpert PC application buttons and menus that were previously described. Before attempting these procedures, you should be familiar with the Anritsu PowerXpert PC application. If an Anritsu Master™ series handheld instrument is being used with the power sensor, refer to the user documentation that came with the handheld instrument for procedures on operating external power sensors.

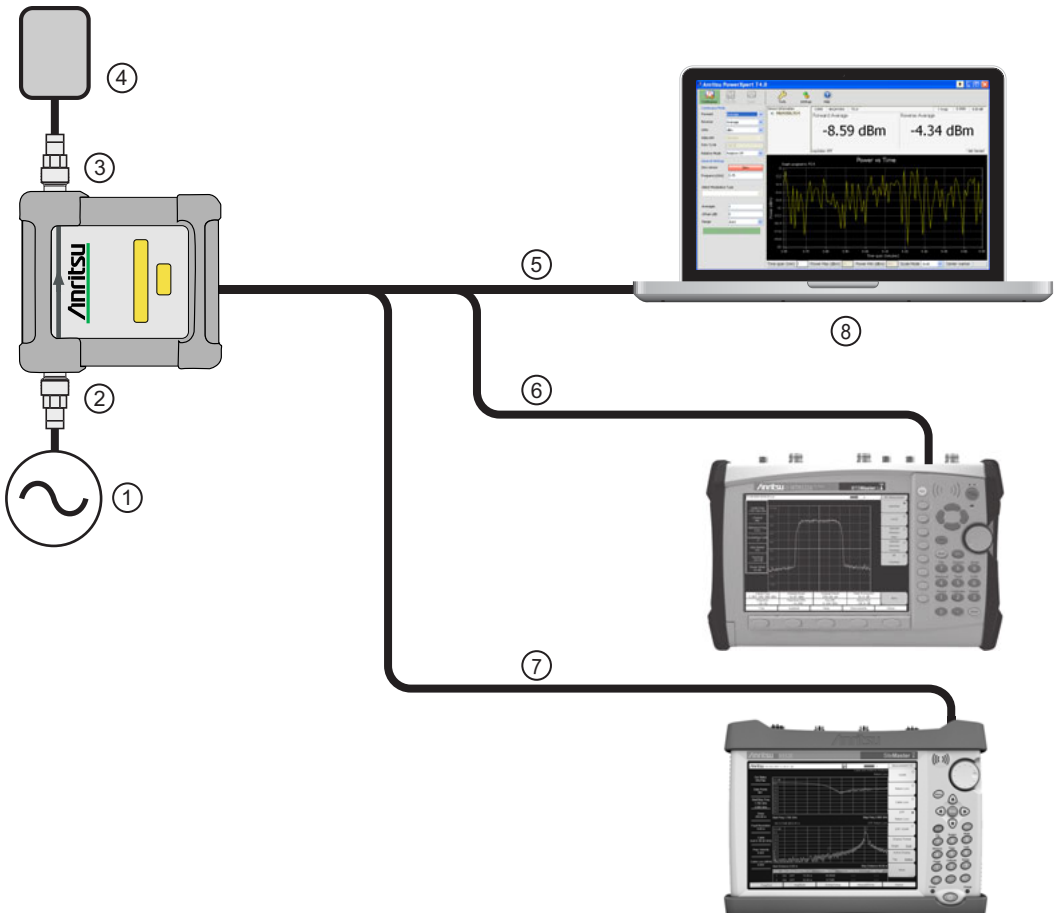
Basic Power Measurement

1. Connect the sensor to a computer or Anritsu Master™ series instrument as shown in Figure 7-2 on page 7-3.
2. Open the Anritsu Power Meter application.
3. Zero the sensor as described below in "Zeroing the Sensor".

Warning	**Do not** connect or apply power outside of the MA24105A specifications or permanent damage may result.

Caution	**Before connecting the power sensor to another device, ensure the following:** Both connectors are in good condition and undamaged Pin depth is verified Both connectors are clean Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor. ESD precautions are observed. Refer to Chapter 4, "Power Sensor Care" for complete details. **When connecting the power sensor, ensure the following:** The connectors are aligned before mating Do not turn the connector body–only the connector coupling nut. Torque the connection using the correct torque wrench and proper torquing technique. Do not over torque. Refer to Chapter 4, "Power Sensor Care" for complete details.

4. Connect the load to the RF OUT port of the sensor. Connecting the load first protects the power sensor as well as the source/DUT from excessive mismatch.
5. Connect the RF source to the RF IN port of the power sensor.
6. Read the power measurement from the Anritsu Power Meter application window (power readings are continuous with the default setting).



Index	Description
1	Source
2	RF In: N type Connector (Torque connector at 12 lbf·in (1.35 N·m)
3	RF Out: N type Connector (Torque connector at 12 lbf·in (1.35 N·m)
4	Load
5	USB to PC
6	USB to BTS or Spectrum Master
7	USB to Site Master or Cell Master
8	PC with Anritsu PowerXpert Application

Figure 7-2. Measurement Setup

Connecting the Sensor

RF signal connections are made to the Type N female RF connectors, which have a 50 Ω characteristic impedance. The input port is labeled RF IN and the output port is labeled RF OUT.

When connecting to the Type N female connector of the MA24105A to a Type N connector, observe the following proper practice for tightening the connection:

1. While holding the body of the N connector in one hand, turn the Type N Male connector nut to finger tighten the connection. **Do not** turn the body of the MA24105A as this will cause excessive wear to the connector.
2. Back off the connection by turning the connector nut counter clockwise ¼ turn.
3. Tighten the connection (clockwise) using a 12 in-lb torque wrench (Anritsu part number: 01-200).

Note	The Sensor has a USB 2.0 interface with a USB Type Micro-B port. The MA24105A can be remotely programmed over this USB interface. In addition to programming, the MA24105A is powered by the USB. The interface is USB 2.0 compatible, but with an interface speed of 12 Mbps.

Zeroing the Sensor

Zero the sensor before making power measurements. If frequent low-level measurements are being made, it is advised to check the sensor zeroing often and repeat as necessary. If the sensor goes into sleep mode, the sensor must be re-zeroed before taking measurements. Before zeroing the sensor, connect it to the DUT (device under test) test port and remove RF power from the connection to a level 20 dB below the noise floor of the power sensor. For the MA24105A power sensor, this level is less than –20 dBm. It is preferable to leave the sensor connected to the DUT test port so that ground noise and thermal EMF (electro-magnetic fields) are zeroed out of the measurement. The sensor may also be connected to a grounded connector on the DUT or disconnected from any signal source.

To zero the sensor, click the **Zero** button on the application. If the sensor fails the zeroing operation, the message box states “Sensor zero failed” and “ZERO_ERROR” will be displayed on the application screen until the problem is corrected. If RF is detected, a reminder message will pop up asking to remove the RF source.

Calibrating the Sensor

The signal channel/analog signal acquisition hardware is integrated along with the RF front end of the power sensor. All of the necessary frequency and temperature corrections take place within the sensor. Therefore, there is no need for a reference calibration with the MA24105A.

Applying a Calibration Factor Correction

The MA24105A power sensor has an internal EEPROM containing correction and calibration factors that were programmed into the sensor at the factory. The power sensor has an internal temperature sensor that reports its readings periodically to the microprocessor. The sensor makes all of the required calculations on the measurement once the measurement frequency has been entered by the user.

Optimizing the Readings

This section presents information on how to get the fastest readings from the MA24105A power sensor when using the Anritsu Power Meter application or operating under remote control (refer to Chapter 13 for specific remote programming command descriptions). Measurement speed depends greatly on the type of measurement, the power level, and stability of the signal. Stability of a measurement is influenced by noise and signal modulation. If high resolution is required, averaging must be increased.

Note	The values in the following tables are typical and should be used as a reference only.

Table 7-1 describes the number of averages needed to attain a certain noise level for a particular power level measurement when measuring forward average power.

Table 7-1. MA24105A Averaging Table (Forward Average Power)

Input Power (dBm)	Input Power (W)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
50	100	1	1	1	1	1
45	31.6	1	1	1	1	1
40	10.0	1	1	1	1	1
35	3.16	1	1	1	1	1
30	1.00	1	1	1	1	1
25	0.316	1	1	1	1	7
20	0.100	1	1	1	3	69
15	0.0316	2	4	7	28	–
10	0.0100	18	32	70	276	–
5	0.00316	179	314	–	–	–

Table 7-2, describes the number of averages needed to attain a certain noise level for a particular power level measurement when measuring forward peak power.

Table 7-2. MA24105A Averaging Table (Forward Peak Power)

Input Power (dBm)	Input Power (W)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
50	100	1	1	1	1	2
45	31.6	1	1	1	1	13
40	10.0	1	1	2	6	126
35	3.16	4	6	13	51	–

7-3 Measurement Considerations

Multitone Signals

The MA24105A is a True-RMS sensor that can measure very wide bandwidth modulation. The only limitation is the frequency flatness of the sensor. Because the sensor's sensitivity is not identical for all frequencies and when measuring multitone signals, the frequency entered into the sensor's application should be the average frequency of all significant tones.

The MA24105A has an error of 0.05 dB for every 100 MHz bandwidth at frequencies between 0.5 GHz and 4 GHz, and an error of 0.5 dB for every 100 MHz bandwidth at frequencies below 0.6 GHz.

Noise and Averaging

When there is a need to achieve a required reading resolution, particularly at low power levels, averaging is often needed to reduce noise and steady the displayed power reading. Use the noise vs. resolution tables (Table 7-1 and Table 7-2 on page 7-5) to determine the number of averages that will typically be required for a given resolution. Alternatively, determine the number of averages through calculation by using the noise specifications and the fact that noise will be proportional to the square root of N, where N is the number of averages.

For example, a CW tone at +25 dBm is to be measured to 0.01 dB resolution. Using Table 7-1, the required number of averages is seven averages when measuring average power in the forward direction.

Settling Time

The MA24105A samples power continuously every 150 ms. The sensor's front end and digitizer settles completely to a step change in power in this amount of time. However, there is no way to synchronize the sensor's sampling to any other event, such as a power step or bus request for a measurement. Therefore, the first measurement requested from the sensor after a power step may not be fully settled. To ensure a fully settled measurement when operating the sensor over the bus, wait 150 ms after a power step before requesting the measurement from the sensor. Alternatively, request two measurements from the sensor and discard the first.

If averaging is required as described above, settling time increases by N × sample period, where N is the number of averages and the sample period is the time in milliseconds. The measurement sample period is 150 ms. When operating the sensor over the bus, request N+1 measurements from the sensor, discard the first, and then average the subsequent readings. The settling time is approximately (N+1) × sample period.

Maximum Power

The MA24105A is rated to meet all specifications up to an average input power level of 150 Watts. Although the average power of all signals should be kept at or below this level, time varying and burst signals having peak powers less than 300 W can be measured. To ensure accurate readings, the peak-to-average ratio (crest factor) of signals must be less than 12 dB.

Warning	Power in excess of that shown in Figure 7-3 on page 7-7 may damage the sensor.

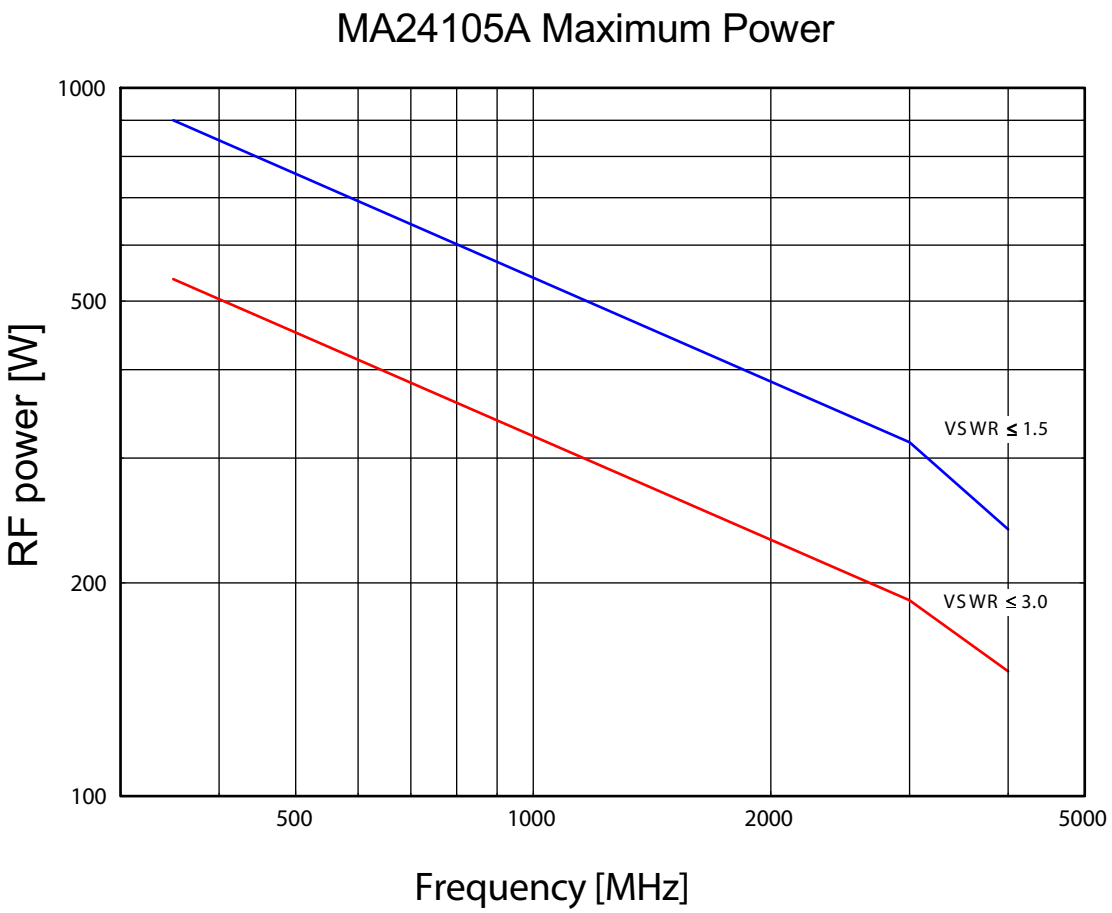


Figure 7-3. Maximum Power Handling Capacity

7-4 Uncertainty of a Measurement

Measurement Uncertainty Calculator

Included on the Power Expert CD-Rom is a Microsoft Excel tool for calculating power uncertainty. It is accessible from the Startup.htm page. It contains two tabs; one that provides measurement uncertainty for each sensor (selectable from a drop-down menu), and another tab that provides additional uncertainty components and calculated values for the MA24105A Peak Power Sensor.

Uncertainty Components

Power measurements have many component parts that affect overall measurement uncertainty when measuring power with the MA24105A sensor:

- **Measurement Uncertainty:** Measurement uncertainty includes the uncertainty associated with the correction of frequency and the linearity response of the sensor over the entire dynamic range. Anritsu follows the industry standard condition of calibrating the power-sensing element at a reference power of 0 dBm (1 mW) and an ambient temperature of 25° C.
- **Temperature Compensation:** Sensor Temperature Compensation describes the relative power level response over the dynamic range of the sensor. Temperature Compensation should be considered when operating the sensor at other than room temperature.
- **Noise, Zero Set, and Zero Drift:** These are factors within the sensor that impact measurement accuracy at the bottom of the power sensor's dynamic range.
- **Mismatch Uncertainty:** Mismatch uncertainty is typically the largest component of measurement uncertainty. The error is caused by the differing impedances between the power sensor and the devices to which the power sensor is connected. Mismatch uncertainty can be calculated as follows:
  - **Source Mismatch:**

    $\%\ \text{Source Mismatch Uncertainty} = 100\left[|1 + \Gamma_1\Gamma_2|^2 - 1\right]$

    $\text{dB Mismatch Uncertainty} = 20\log|1 + \Gamma_1\Gamma_2|$
  - **Load Mismatch (not considering inline power sensor insertion loss):**

    $\%\ \text{Load Mismatch Uncertainty} = 100\left[|1 + \Gamma_2\Gamma_3|^2 - 1\right]$

    $\text{dB Load Mismatch Uncertainty} = 20\log|1 + \Gamma_2\Gamma_3|$
  - **Load Mismatch (considering inline power sensor insertion loss):**

    $\%\ \text{Load Mismatch Uncertainty} = 100\left[|1 + \mathbf{t}^2\Gamma_2\Gamma_3|^2 - 1\right]$

    $\text{dB Load Mismatch Uncertainty} = 20\log|1 + \mathbf{t}^2\Gamma_2\Gamma_3|$
- **Directivity Uncertainty:**

  $\%\ \text{Uncertainty due to Finite Directivity} = 100\left[(1 + \Gamma_3/\mathbf{D})^2 - 1\right]$

where:

D is the directivity of the inline power sensor expressed in linear units

Γ_1 is the reflection coefficient of the inline power sensor

Γ_2 is the reflection coefficient of the source

Γ_3 is the reflection coefficient of the load

t is the inline power sensor's transmission coefficient

$\mathbf{t} = 10^{(IL/20)}$

IL = Insertion Loss of the inline power sensor

Uncertainty Examples

Two measurement uncertainty calculations for the MA24105A are shown in Table 7-3. The MA24105A is used to measure the power of a 1 GHz, +50.0 dBm and +10 dBm CW signal from a signal source with a 1.5:1 VSWR and a load having a 1.2:1 VSWR. The example is based on 128 measurement averages.

Table 7-3. Measurement Uncertainty Examples

Uncertainty Term	Uncertainty at +50 dBm (%)	Uncertainty at +10 dBm (%)	Probability Distribution	Divisor	Adjusted Uncertainty at +50 dBm (%)	Adjusted Uncertainty at +10 dBm (%)
Measurement Uncertainty	3.8	3.8	Normal at 2σ	2	1.9	1.9
Noise	0.0	1.7	Normal at 2σ	2	0.0	0.9
Zero Set	0.0	2.5	Rectangular	√3	0.0	1.4
Zero Drift	0.0	2.3	Normal at 2σ	2	0.0	1.3
Directivity Induced Uncertainty	0.6	0.6	Rectangular	√3	0.3	0.3
Source Mismatch Uncertainty	1.4	1.4	Rectangular	√3	0.8	0.8
Load Mismatch Uncertainty	3.7	3.7	Rectangular	√3	2.1	2.1
Effect of Digital Modulation	0	0	Rectangular	√3	0	0
Combined Uncertainty (RSS) Room Temperature					3.0	3.7
Expanded Uncertainty with K=2 Room Temperature					6.0	7.3
Temperature Compensation	1.9	1.9	Rectangular	√3	1.1	1.1
Combined Uncertainty (RSS, 0 to 50 °C)					3.2	3.8
Expanded Uncertainty with K=2 (RSS, 0 to 50 °C)					6.3	7.6

Table 7-4. Noise Measurement Uncertainty Calculations

Noise Calculations at 50 dBm (100 W):	
Noise	1.9 mW/100 W = 0.0 %
Zero Set	3 mW/100 W = 0.0 %
Zero Drift	2.7 mW/100 W = 0.0 %
Noise Calculations at +10 dBm (10 mW):	
Noise	170 µW/10 mW = 1.7 %
Zero Set	250 µW/10 mW = 2.5 %
Zero Drift	230 µW/10 mW = 2.3 %

Table 7-5 shows another example measuring a pulse signal of +50dBm at a repetition rate of 80/S with a duty cycle of 8 %.

Table 7-5. Uncertainty Example - Pulse Signal (MA24105A)

PEP Uncertainty Components				
Power Sensor	**Uncertainty at +50 dBm (%)**	**Probability Distribution**	**Divisor**	**Adjusted Uncertainty at +50 dBm (%)**
Base Unc (Average Power Uncertainty)	6.3	Normal	2	3.2
Peak Circuit Contribution	7.3	Rectangular	√3	4.2
Burst Repetition Rate	1.8	Rectangular	√3	1.0
Burst Width	0.0	Rectangular	√3	0.0
Burst Duty Cycle	0.1	Rectangular	√3	0.1
PEP Measurement Uncertainty				
Combined Uncertainty (%) (Base Unc + RSS)				7.5
Expanded Uncertainty (%) with K=2				15.0

7-5 Error States

This section details some of the error messages that may appear on the application screen. In most cases, the error condition can be easily corrected. The status LED will light amber when an error state occurs. If not, note the error message and contact an Anritsu Service Center.

Table 7-6. Error Messages

Message	Description	Resolution
Zero invalid as temperature changed by more than 10 Degrees C	The sensor's ambient temperature has changed by more than 10 ºC since the last zero operation.	Perform the zero operation again.
Temperature out of operating range	The sensor is operating outside of its specified range of 0 ºC to 55 ºC.	Operate the sensor within its specified range.
Sensor zero failed	This message box appears if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ZERO_ERROR	This message appears on the application screen if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ADC_TEMP_OVERRNGE	This message appears on the application screen if the sensor is being operated in extremely high temperatures and has overheated.	Remove the sensor from the USB connection and allow to cool to the operating range of the sensor: 0 ºC to 55 ºC

Chapter 8 — Operational Testing for the MA24105A

8-1 Introduction

The test methodology and equipment described here can be used to gain some confidence in the measurement accuracy of the MA24105A Power Sensor. This is accomplished by comparing the sensor to another sensor with a specified cal factor and linearity performance or uncertainty. General commercially available equipment is used for these tests; however, these procedures are not sufficiently accurate to verify sensors to factory specification. Therefore, sensor test limits in these procedures are set appropriately to the specified comparison equipment. All tests should be performed at an ambient temperature of 20 ºC to 25 ºC.

Note	Calibration and verification of high accuracy power sensors requires substantial investment in both skill and equipment. For calibration, calibration verification, and to maintain the factory specifications of your power sensor, please send sensors to a qualified Anritsu Customer Service Center.

Refer to the following sections for required equipment and test procedures:

- "Required Equipment - MA24105A"
- "VSWR Pretest"
- "Directivity Test"
- "Frequency Response Test"
- "Linearity Test"

8-2 Precautions

Warning	**Do not** connect or apply power outside of the power sensor specifications or permanent damage may result.

Caution	**Before connecting the power sensor to another device, ensure the following:** Both connectors are in good condition and undamaged Pin depth is verified Both connectors are clean Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor. ESD precautions are observed. Refer to Chapter 4, "Power Sensor Care" for complete details. **When connecting the power sensor, ensure the following:** The connectors are aligned before mating Do not turn the connector body–only the connector coupling nut. Torque the connection using the correct torque wrench and proper torquing technique. Do not over torque. Refer to Chapter 4, "Power Sensor Care" for complete details.

8-3 Required Equipment - MA24105A

Table 8-1. Required Equipment

Equipment Description	Manufacturer and Model	Critical Specifications
Vector Network Analyzer (Pretest)	Anritsu MS4642A or equivalent	Reflection Coefficient Uncertainty ≤ 0.013, 350 MHz to 2 GHz Uncertainty ≤ 0.020, 2 GHz to 4 GHz
Synthesizer (Cal. Factor and Linearity Tests)	Anritsu MG3692B or equivalent	Output Power: ≥ +20 dBm 0.05 GHz to 4 GHz Output Power Setting Resolution: 0.01 dBm Harmonics: ≤ –40 dBc Source VSWR ≤ 2.00
Reference Power Meter (Cal. Factor and Linearity Tests)	Anritsu ML2438A or equivalent	Instrumentation Accuracy ≤ 0.5 %
Reference Power Sensor (Cal. Factor and Linearity Tests)	Anritsu MA24002A or equivalent	NIST Calibration or equivalent
10 dB N Attenuator (Linearity Test)	Aeroflex Model 1433	VSWR ≤ 1.15, 350 MHz to 4 GHz, 250 W min.
10 dB K Attenuator (Frequency Response and Linearity Tests)	Anritsu 41KC-10	VSWR ≤ 1.15, 350MHz to 4 GHz, 2 W min.
Low Power 30 dB N Attenuator (Linearity Tests)	42N50A-30	VSWR ≤ 1.2, 350 MHz to 4 GHz, 30 W min.
50 ohm Termination	Aeroflex Model 1433	VSWR ≤ 1.15, 350 MHz to 4 GHz, 250 W min.
Adapter N(f) to K(f) (Frequency Response and Linearity Tests)	Anritsu 34ANF50, 34AS50, 34AN50, and 34ASF50	VSWR ≤ 1.05, 350 MHz to 4 GHz
Power Coupler (Linearity Test)	MITEQ CD2-522-30N	350 MHz to 4.0 GHz, Coupling = 30 dB, 250 W min.
Amplifier (Directivity, Frequency Response and Linearity Tests)	Ophir 5163, 5125	350 MHz to 4.0 GHz, 250 W min. Harmonics < –20 dBc Spurious < –20 dBc
Personal Computer	Any	See Chapter 2

8-4 VSWR Pretest

Excessive mechanical shock can cause a failure in the MA24105A. Excessive shock may cause permanent internal mechanical displacements that results in impedance change. Input match will be degraded when the coupling element impedance is changed. If you suspect that a sensor is damaged, you should start with an input match pretest.

The maximum VSWR values are listed in the Performance Specification section of this manual. The uncertainty of the VSWR test equipment will affect actual measurement values. Table 8-2 shows how measurement system uncertainty can affect the Expected Maximum Reflection Coefficient when using the Anritsu MS4642A Vector Network Analyzer.

Test Procedure

Follow the manufacturers S_{11} (or return loss) calibration procedure to perform calibration on a network analyzer. Connect the power sensor to the network analyzer test port and measure power sensor input match. Typically, matches are measured in terms of return loss in dB. Return loss and magnitude of the reflection coefficient conversion equations are as follows:

$$\rho = 10^{-RL/20}$$

$$RL = -20\log\rho$$

where

RL = Return Loss in dB

ρ = Magnitude of the Reflection Coefficient

VSWR and magnitude of the reflection coefficient conversion equations are as follows:

$$VSWR = (1 + \rho) / (1 - \rho)$$

$$\rho = (VSWR - 1) / (VSWR + 1)$$

where

VSWR = Voltage Standing Wave Ratio

ρ = Magnitude of the Reflection Coefficient

Record the measured data to Table 8-2 in the Actual Measurement column. The Actual Measurement should be smaller than the Maximum Reflection Coefficient. The Maximum Reflection Coefficient is the measurement system uncertainty added to the sensor's reflection coefficient specification. If the Actual Measurement reflection coefficient is larger than the Maximum Reflection Coefficient, then the power sensor may be defective. If the actual reflection coefficient is significantly larger than the maximum values in Table 8-2, then the sensor is damaged and it is not necessary to perform further testing.

Note	There are no user-serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return defective sensors with a detailed description of the observed problem.

Table 8-2. Pretest Measurement Result

Frequency	MS4642A Reflection Coefficient Uncertainty	Maximum Reflection Coefficient	Actual Measurement
350 MHz to 3 GHz	0.013	0.033 + 0.013 = 0.046	
3 GHz to 4 GHz	0.020	0.047 + 0.020 = 0.067	

8-5 Directivity Test

The most common cause of power sensor failure is excess input power. Applying power that exceeds the damage level shown on the label will damage the coupling element in the MA24105A, resulting in directivity change. Excessive mechanical shock can also cause directivity to change.

Test Procedure

Directivity tests an MA24105A for how selective the sensor is when measuring power in a given direction of travel and rejecting signals traveling in the opposite direction. The simplified equations below give the first order approximation of this parameter:

Directivity (dB) = Power Forward (dB) – Power Reverse (dB)

Directivity Coefficient = $10^{(-\text{Directivity (dB)} / 20)}$

Directivity (dB) = $-20 \times \log(\text{Directivity Coefficient})$

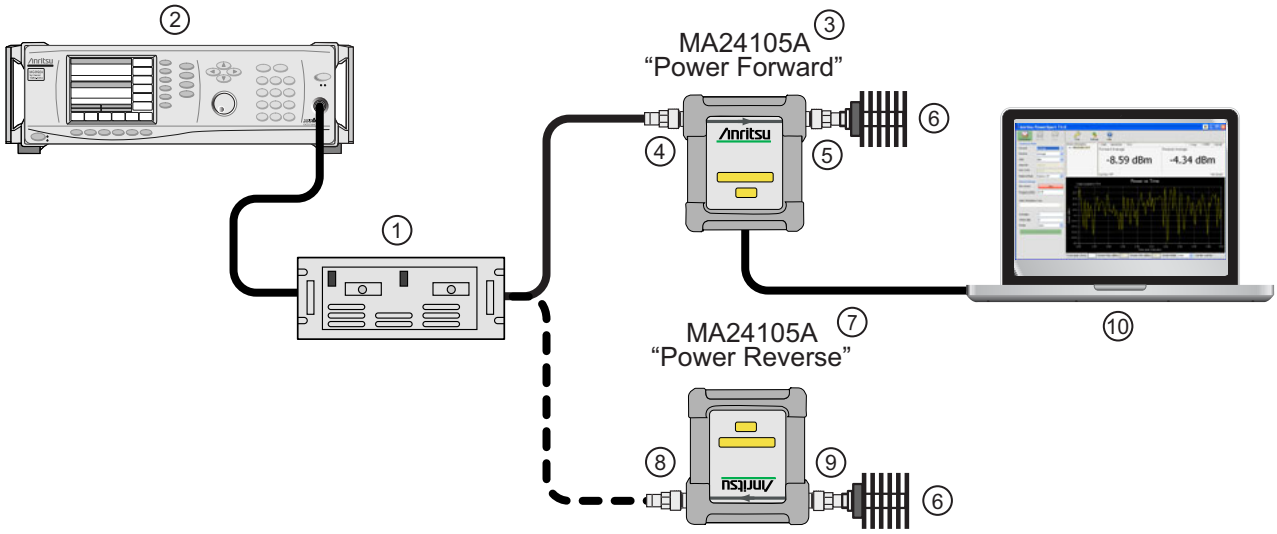
Directivity (dB) = $10 \times \log(\text{Power Forward} / \text{Power Reverse})$, where power is in watts.

In this test, the MA24105A is tested first with power in the forward direction and then with power in the reverse direction. See Figure 8-1 on page 8-5.

Note	Both forward and reverse readings are taken from the Forward Average Power window on the PowerXpert display as shown in Figure 8-2 on page 8-5.

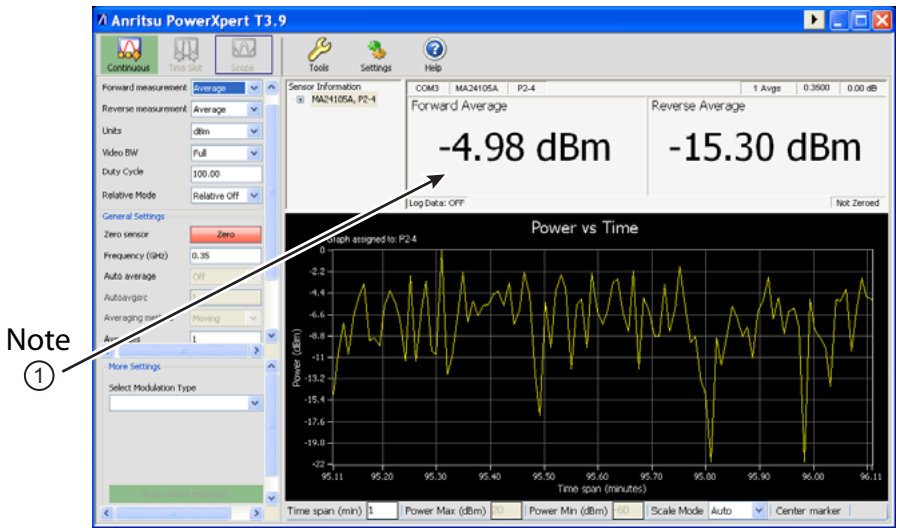
The ratio of the two power readings are the directivity of the device assuming that both the termination and source are perfect 50 ohm matches. Since the termination and source are not perfect matches, residual effects from multiple reflections need to be accounted for by performing the following procedure.

1. Turn off the RF of the synthesizer. Connect the power amplifier to the synthesizer. Connect the output of the amplifier to the input of the MA24105A. Terminate the output of the MA24105A with the specified termination (Figure 8-1).
2. With the RF off, zero the MA24105A.
3. Set the synthesizer to the first frequency in Table 8-3 on page 8-6 and to a very low power setting and slowly increase the power until the MA24105A displays +30 dBm. Allow the devices to warm up for 30 minutes.
4. Turn off the RF of the synthesizer and zero the MA24105A again.
5. Turn on the RF and adjust the synthesizer until the MA24105A displays approximately +44 dBm. Confirm that the reading is stable and record this value as Power Forward in Table 8-3.
6. Turn off the RF on the synthesizer.
7. Reverse the MA24105A connections to the termination and the amplifier. Confirm that the MA24105A output is now connected to the amplifier and that the input is connected to the termination (Figure 8-1).
8. Turn on the RF. Change the MA24105A averages if necessary to see a steady reading. Record the value as Power Reverse in Table 8-3.
9. Calculate the Actual Directivity in dB by subtracting Power Reverse from Power Forward. If the power is in watts, use the formula noted above to calculate the Actual Directivity in dB.
10. If the actual directivity is larger than the minimum allowable directivity in Table 8-3, contact Anritsu customer service.
11. Repeat the steps above for the next frequency in Table 8-3.



Index	Description
1	Amplifier
2	Synthesizer
3	MA24105A "Power Forward" Measurement
4	RF In: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
5	RF Out: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
6	50 ohm Termination
7	MA24105A "Power Reverse" Measurement
8	RF Out
9	RF In
10	PC with Anritsu PowerXpert Application

Figure 8-1. Directivity Test Set Up for Power Forward and Power Reverse



Note 1: Take both the forward reading and the reverse reading from the Forward Average Power window.

Figure 8-2. Forward and Reverse Power Reading Location

Table 8-3. Directivity Test Measured Results

Frequency (GHz)	Reflective Coefficient of Termination	Maximum Directivity Coefficient	A Power Forward (dB)	B Power Reverse (dB)	A – B Actual Directivity (dB)	Minimum Allowable Directivity (dB)
0.35	0.048	0.088				21.1
1.0	0.048	0.079				22.0
1.5	0.048	0.079				22.0
2.0	0.048	0.079				22.0
2.5	0.048	0.101				19.9
3.0	0.048	0.101				19.9
3.5	0.048	0.120				18.4
4.0	0.048	0.120				18.4

8-6 Frequency Response Test

In this test the frequency response of the sensor is tested at one low power level against a reference sensor of known measurement uncertainty. The reference sensor should be calibrated by a reputable standards laboratory using instruments with low published measurement uncertainty values. To perform the comparison, both sensors are used to measure the output power of a synthesizer with a high quality attenuator, such as the 41KC-10, on the output. The attenuator improves the source match of the synthesizer by lowering the mismatch ripples, thereby lowering the uncertainty in the comparison.

Test Procedure

1. Set up the equipment as follows (see Figure 8-3):

a. Connect the reference power sensor to the reference power meter using the appropriate cables.

b. Connect the USB cable between the personal computer with the PowerXpert application installed and the MA24105A power sensor under test.

c. Launch the PowerXpert application.

d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in their respective manuals.

e. Reset or Preset all of the instruments.

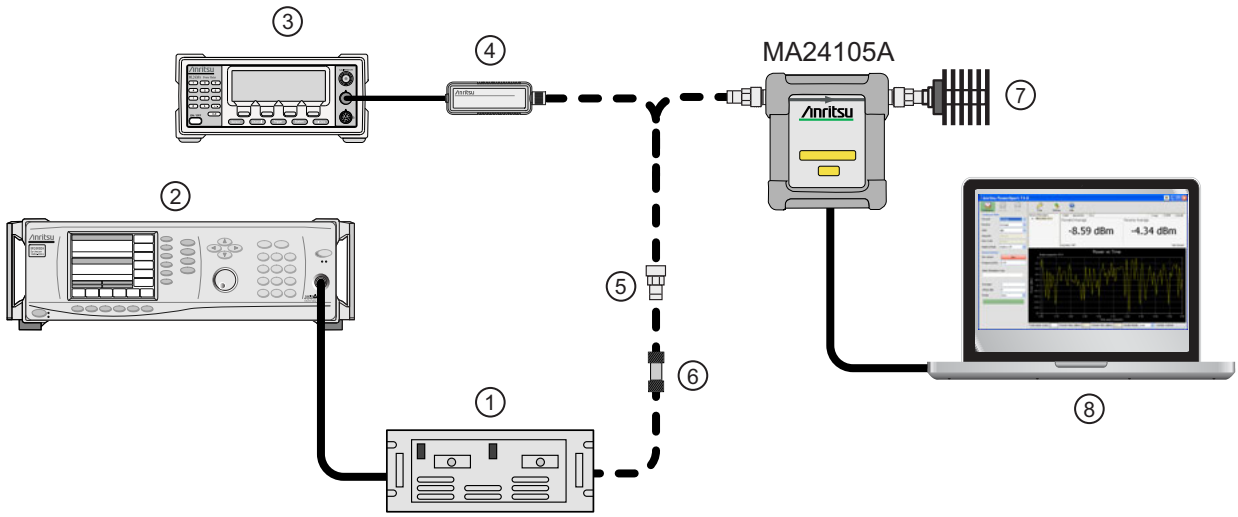
f. Configure the reference meter and sensor to measure a CW signal.

g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

h. Perform a low-level Zero of the MA24105A by disconnecting the MA24105A from the synthesizer, clicking the **Zero** button on the PowerXpert application, and waiting for the Zeroing message to close.

i. Connect the synthesizer to the amplifier input. Connect the attenuator to the amplifier output, then connect the appropriate adapter to the output of the attenuator.

j. Set the synthesizer to 350 MHz and a very low power output.



Index	Description
1	Amplifier
2	Synthesizer
3	Reference Power Meter

Figure 8-3. Frequency Response Test Set Up (1 of 2)

4	Reference Power Sensor
5	K to N Adapter
6	Attenuator
7	50 ohm Termination
8	PC with Anritsu PowerXpert Application

Figure 8-3. Frequency Response Test Set Up (2 of 2)

2. Connect the reference sensor to the amplifier with the appropriate adapter and attenuator in-line (see Figure 8-3).
3. Apply the Cal factor to the reference sensor per the manufacturer's instruction.
4. Adjust the synthesizer power until the reference displays +15 dBm.
5. Record the power indicated by the reference meter in Table 8-4.
6. Disconnect the reference sensor from the synthesizer output and connect the MA24105A power sensor with the appropriate adapter and attenuator in-line (see Figure 8-3).
7. Apply the Cal factor to the MA24105A by entering the frequency (in GHz) in the PowerXpert application, and then click **Apply above settings**.
8. Record the power indicated by the MA24105A in Table 8-4.
9. Set the synthesizer frequency to the next frequency in Table 8-4.
10. Repeat Step 2 through Step 9 until all of the frequencies in Table 8-4 have been measured.
11. For each row in Table 8-4, calculate the absolute value of the difference between the recorded Reference power measurement and the recorded MA24105A measurement, and record the result in Table 8-4.
12. For each frequency, compare the power difference to the maximum allowed difference specified in Table 8-4. If the difference is higher than the maximum allowed difference, contact Anritsu customer service.

Table 8-4. Test Measurement Results

Frequency (GHz)	A Reference Power Measurement (dBm)	B MA24105A Measurement (dBm)	|A-B| Absolute Value of Difference in Power Measurements (dB)	Maximum Allowed Difference (dB)
0.35				0.33
1.0				0.33
1.5				0.33
2.0				0.33
2.5				0.36
3.0				0.36
3.5				0.37
4.0				0.37

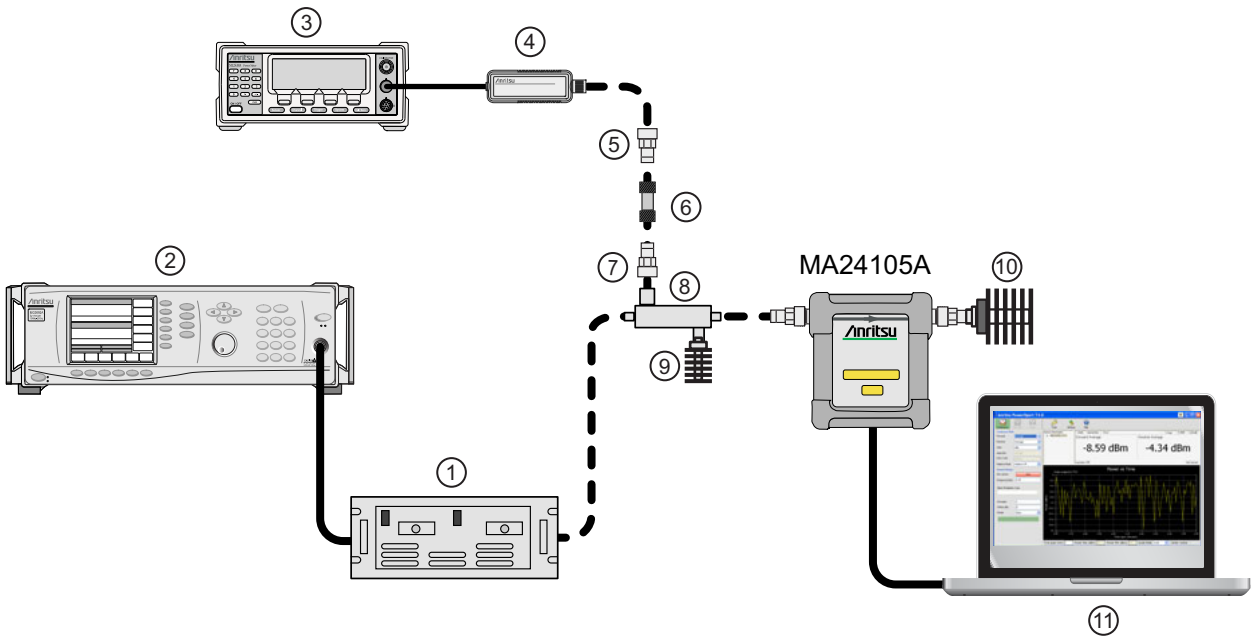
8-7 Linearity Test

The linearity correction of the MA24105A is compared to a thermal power sensor, which has very good inherent linearity over a power range of about –20 dBm to +10 dBm. For this reason, the MA24105A will be compared to the thermal sensor in two *ranges*, keeping the power levels to the thermal sensor in the range of –17 dBm to +5 dBm, while the power to the MA24105A will vary from about –26 dBm to about +14 dBm.

Test Procedure

1. Set up the equipment as follows (refer to Figure 8-4 for an illustration):

- **a.** Connect the reference power sensor to the reference power meter using the appropriate cables.
- **b.** Connect the USB cable between the personal computer with the PowerXpert application installed and the MA24105A power sensor under test.
- **c.** Launch the PowerXpert application.
- **d.** Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in the instrument's respective manuals.
- **e.** Reset or Preset all of the instruments.
- **f.** Configure the reference meter and sensor to measure a CW signal.
- **g.** Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.
- **h.** Perform a low-level Zero of the MA24105A by disconnecting the sensor from the synthesizer, click the **Zero** button in the PowerXpert application, and wait for the Zeroing message to close.
- **i.** Connect the power coupler to the output of the synthesizer and connect the 10 dB K attenuator using an adapter to the coupler's coupling output.
- **j.** Connect the low power 30 dB N attenuator to the other coupling output.
- **k.** Connect the reference sensor to the 10 dB K attenuator using an adapter.
- **l.** Connect the MA24105A to the output of the coupler.
- **m.** Set the synthesizer to 350 MHz and a very low power level.
- **n.** Increase averaging by entering "16" in the PowerXpert application, and then click **Apply above settings**.



Index	Description
1	Amplifier
2	Synthesizer
3	Reference Power Meter
4	Reference Power Sensor
5	K to N Adapter
6	10 dB Attenuator N Type
7	K to N Adapter
8	Power Coupler
9	30 dB N Attenuator
10	50 ohm Termination
11	PC with Anritsu PowerXpert Application

Figure 8-4. Linearity Test Setup 1

2. Apply the Cal factor to the reference sensor per the manufacturer's procedure.

3. Apply the Cal factor to the MA24105A by entering the frequency (in GHz) in the PowerXpert application, and then click **Apply above settings**.

4. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24105A.

5. Turn On the synthesizer's RF output.

6. Adjust the synthesizer's power until the MA24105A is reading approximately +45 dBm.

7. Record data for the first 20 dB range as follows:

a. Record the power reading by the reference meter in Table 8-5.

b. Record the power reading by the MA24105A in Table 8-5.

c. Reduce synthesizer power by 5 dB. The Amplifier output and the MA24105A should be about +40 dBm.

d. Record the reference meter and the MA24105A power sensor readings in Table 8-5.

e. Repeat the measurement for amplifier output levels of +35 dBm, +30 dBm, and +25 dBm.

Note	The MA24105A power measured at +25 dBm will be used in Step 8e, below.

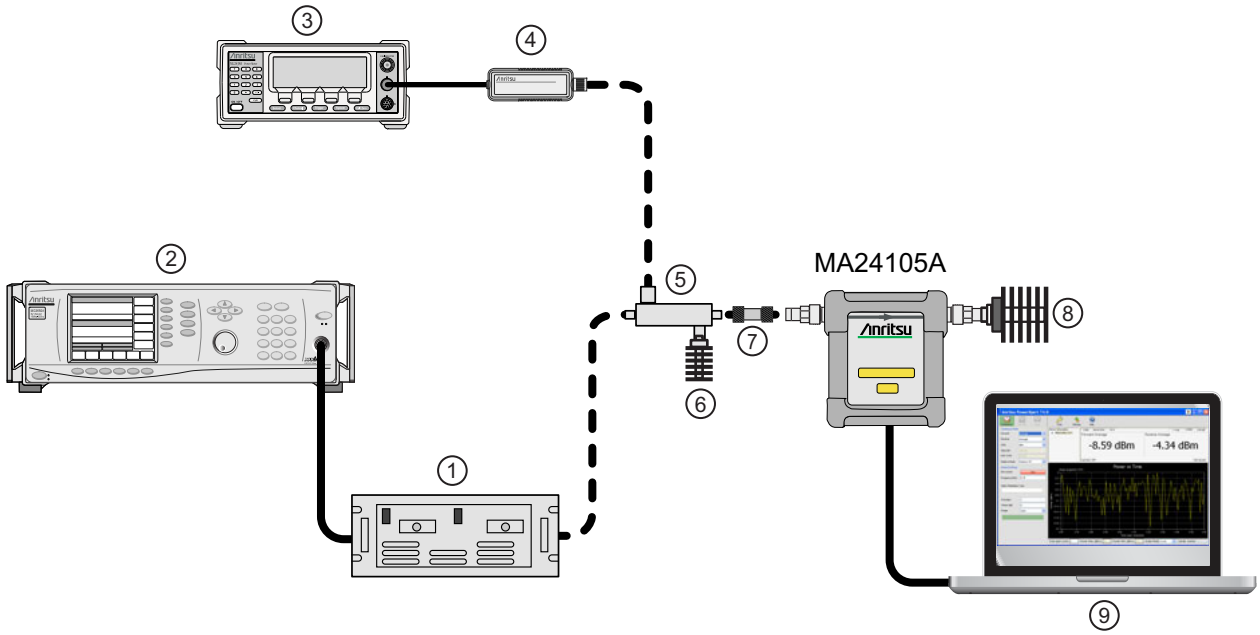
8. Set up the test for the second 20 dB range as follows:

a. Remove the 10 dB K attenuator from in between the reference sensor and coupler, then connect the reference sensor directly to the coupler's coupling port.

b. Remove the MA24105A from the coupler and connect the 10 dB N attenuator between the coupler and the MA24105A power sensor (see Figure 8-5).

c. Turn off the synthesizer RF output and perform a low-level Zero of both the Reference sensor and the MA24105A.

d. Turn on the synthesizer RF output.



Index	Description
1	Amplifier
2	Synthesizer
3	Reference Power Meter
4	Reference Power Sensor
5	Power Coupler
6	30 dB N Attenuator
7	10 dB N Attenuator
8	50 ohm Termination
9	PC with Anritsu PowerXpert Application

Figure 8-5. Linearity Test Setup 2

e. Set the amplifier output level to approximately 5 dB higher and then adjust the output level until the MA24105A reads as close as possible to the value obtained in Step 7e.

9. Record data for the next 20 dB range:

a. Read and record the power indicated by the reference meter in Table 8-5.

b. Lower the output power level of the amplifier by 5 dB. The amplifier output should be about +30 dBm and the MA24105A should be about +20 dBm.

c. Record the reference meter and the MA24105A power sensor readings in Table 8-5.

d. Repeat the measurement for amplifier output levels of +25, +20, and +15 dBm.

Table 8-5. Measurement Results (350 MHz)

Row #	Approx. Output Power of the Amplifier (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6 – A5) Correction (dB)	C = (A + B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24105A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	45	10				0		
2	40	10				0		
3	35	10				0		
4	30	10				0		
5	25	10				0		
6	adjust per Step 8e	0		0		10		
7	30	0		0		10		
8	25	0		0		10		
9	20	0		0		10		
10	15	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

10. Perform the calculations and operational check as follows:

a. Subtract the Reference Power Measurement of row 5 from the Reference Power Measurement of row 6. Record this value in the Correction column of rows 1 through 5.

Note	The Correction column of rows 1 through 5 should all have the same value. The Correction column of rows 6 through 10 have values of 0.

b. Add the Reference Power Measurement and Correction values of row 1 and record the result in the Corrected Reference Power Measurement column of row 1.

c. Repeat Step 10b for rows 2 through 10.

d. Subtract the MA24105A Measurement of row 1 from the Corrected Reference Power Measurement of row 1 and record the result in the Difference Calculation column of row 1.

e. Repeat Step 10d for rows 2 through 10.

f. Find the largest (most positive) value in the Difference Calculation column and record this value next to the word Max in row 11.

g. Find the smallest (least positive or most negative) value in the Difference Calculation column and record this value next to the word Min in row 12.

h. Subtract the Min value from Step 10g from the Max value from Step 10f and record the result next to the word Delta in row 13.

i. The Delta result should be less than 0.3 dB. If it is larger, contact Anritsu customer service.

11. Repeat the entire measurement and calculations with synthesizer frequency settings of 2 GHz and 4 GHz.

Table 8-6. Measurement Results (2 GHz)

Row #	Approx. Output Power of the Amplifier (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24105A Measurement (dBm)	C–D Difference Calculation (dB)
1	45	10				0		
2	40	10				0		
3	35	10				0		
4	30	10				0		
5	25	10				0		
6	adjust per Step 8e	0		0		10		
7	30	0		0		10		
8	25	0		0		10		
9	20	0		0		10		
10	15	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 8-7. Measurement Results (4 GHz)

Row #	Approx. Output Power of the Amplifier (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24105A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	45	10				0		
2	40	10				0		
3	35	10				0		
4	30	10				0		
5	25	10				0		
6	adjust per Step 8e	0		0		10		
7	30	0		0		10		
8	25	0		0		10		
9	20	0		0		10		
10	15	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Chapter 9 — Using the MA24106A

9-1 Sensor Overview

The MA24106A power sensor is illustrated in the figure below:

Index	Description
1	RF Input: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m)
2	2-color LED (reports functional status of the sensor) **Green:** Sensor ON, Status OK **Amber:** Error or Programming Condition
3	USB Mini-B Port (for connection with a PC or Anritsu handheld instrument)

Figure 9-1. MA24106A Sensor Overview

9-2 Making Measurements

This section presents common procedures for using the MA24106A power sensor with a PC. These procedures refer to the MA24106A sensor and Anritsu PowerXpert PC application buttons and menus that were previously described. Before attempting these procedures, you should be familiar with the Anritsu PowerXpert PC application. If an Anritsu Master™ series handheld instrument is being used with the power sensor, refer to the user documentation that came with the handheld instrument for procedures on operating external power sensors.

Basic Power Measurement

Caution	The supplied USB cable with the screw-in connector should be securely fastened to the sensor to avoid damage to the mini-USB connector.

To perform a power measurement:

1. Connect the sensor to a computer as shown in Figure 9-2.
2. Open the Anritsu Power Meter application.

3. Zero the sensor as described below in "Zeroing the Sensor".

Warning	**Do not** connect or apply power outside of the MA24106A specifications or permanent damage may result.

Caution	**Before connecting the power sensor to another device, ensure the following:** Both connectors are in good condition and undamaged Pin depth is verified Both connectors are clean Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor. ESD precautions are observed. Refer to Chapter 4, "Power Sensor Care" for complete details. **When connecting the power sensor, ensure the following:** The connectors are aligned before mating Do not turn the connector body–only the connector coupling nut. Torque the connection using the correct torque wrench and proper torquing technique. Do not over torque. Refer to Chapter 4, "Power Sensor Care" for complete details.

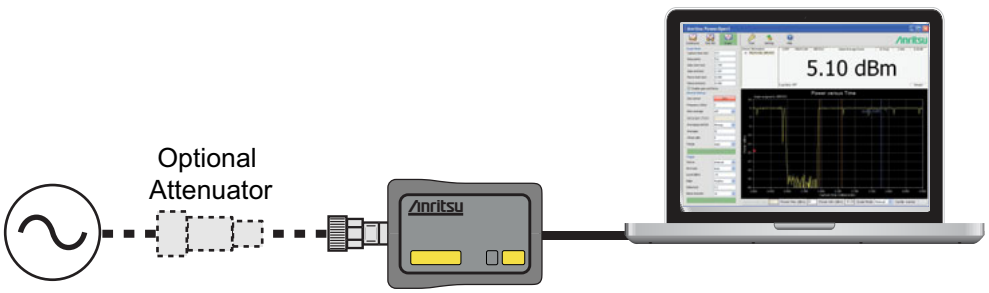


Figure 9-2. Measurement Setup

4. Connect the power sensor to an RF source.
5. Read the power measurement from the Anritsu PowerXpert application window (power readings are continuous with the default setting).

Connecting the DUT

RF signal connections are made to the Type N male RF connector, which has a 50 ohm characteristic impedance.

When connecting to the Type N connector of the MA24106A to a Type N female connector, observe the following proper practice for tightening the connection:

1. While holding the body of the sensor in one hand, turn the Type N Male connector nut to finger tighten the connection. Do not turn the body of the MA24106A as this will cause excessive wear to the connector.
2. Back off the connection by turning the connector nut counter clockwise ¼ turn.
3. Tighten the connection (clockwise) using a 12 in-lb torque wrench (Anritsu part number: 01-200).

Note	The Sensor has a USB 2.0 interface with a USB Type Mini-B port. The MA24106A can be remotely programmed over this USB interface. In addition to programming, the MA24106A is powered by the USB. The interface is USB 2.0 compatible, but with an interface speed of 12 Mbps.

Zeroing the Sensor

Zero the sensor before making power measurements, particularly when operating within the lower 20 dB dynamic range of the power sensor. If frequent low-level measurements are being made, it is advised to check the sensor zeroing often and repeat as necessary. Before zeroing the sensor, connect it to the DUT (device under test) test port and remove RF power from the connection to a level 20 dB below the noise floor of the power sensor. For the MA24106A power sensor, this level is less than –60 dBm. It is preferable to leave the sensor connected to the DUT test port so that ground noise and thermal EMF (electro-magnetic fields) are zeroed out of the measurement. The sensor may also be connected to a grounded connector on the DUT or disconnected from any signal source.

To zero the sensor, click the **Zero** button on the application. If the sensor fails the zeroing operation, the message box states “Sensor zero failed” and “ZERO_ERROR” will be displayed on the application screen until the problem is corrected. If RF is detected, a reminder message will pop up asking to remove the RF source.

Calibrating the Sensor

The signal channel/analog signal acquisition hardware is integrated along with the RF front end of the power sensor. All of the necessary frequency and temperature corrections take place within the sensor. Therefore, there is no need for a reference calibration (at 50 MHz and 1 mW) with the MA24106A.

Applying a Calibration Factor Correction

The MA24106A power sensor has an internal EEPROM containing correction and calibration factors that were programmed into the sensor at the factory. The power sensor has an internal temperature sensor that reports its readings periodically to the microprocessor. The sensor makes all of the required calculations on the measurement once the measurement frequency has been entered by the user.

Optimizing the Readings

This section presents information on how to get the fastest readings from the MA24106A power sensor when using the Anritsu Power Meter application or operating under remote control (refer to Chapter 13 for specific remote programming command descriptions). Measurement speed depends greatly on the type of measurement, the power level, and stability of the signal. Stability of a measurement is influenced by noise and signal modulation. If high resolution is required, averaging must be increased.

Note	The values in the following tables are typical and should be used as a reference only.

Table 9-1 describes the number of averages needed to attain a certain noise level for a particular power level measurement with the Low Aperture Time mode setting.

Table 9-1. MA24106A Averaging Table (Low Aperture Time, Default Mode)

Input Power (dBm)	Input Power (mW)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
20	100	1	1	1	1	1
15	31.6	1	1	1	1	1
10	10.0	1	1	1	1	1
5	3.16	1	1	1	1	2
0	1.00	1	1	1	4	16
-5	0.316	1	1	1	20	78
-10	0.100	1	1	1	1	1
-15	0.0316	1	1	1	1	1
-20	0.0100	1	1	1	1	7
-25	0.00316	1	1	1	3	61
-30	0.00100	2	3	7	25	–
-35	0.000316	16	28	62	245	–
-40	0.000100	158	–	–	–	–

Table 9-2, describes the number of averages needed to attain a certain noise level for a particular power level measurement with the High Aperture Time mode setting.

Table 9-2. MA24106A Averaging Table (High Aperture Time)

Input Power (dBm)	Input Power (mW)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
20	100	1	1	1	1	1
15	31.6	1	1	1	1	1
10	10.0	1	1	1	1	1
5	3.16	1	1	1	1	1
0	1.00	1	1	1	1	1
-5	0.316	1	1	1	2	5
-10	0.100	1	1	1	1	1
-15	0.0316	1	1	1	1	1
-20	0.0100	1	1	1	1	1
-25	0.00316	1	1	1	1	4
-30	0.00100	1	1	1	2	38
-35	0.000316	1	2	4	16	–
-40	0.000100	10	18	39	153	–

9-3 Measurement Considerations

Time Varying Signals

Case 1: Modulated signals with pulse or pattern repetition times ≤ 1 ms (PRF ≥ 1 KHz)

If you obtain a steady power reading of a modulated signal (no significant fluctuations of the displayed power) with no averaging, then it is likely that the pulse or pattern repetition rate is greater than 1 KHz. In this case, most of the averaging of the envelope power is performed in the front end of the sensor (before being digitized). When this is the case, the MA24106A will provide an accurate indication of the average power with no special considerations.

Case 2: Modulated signals with pulse or pattern repetition times between 1 ms and 50 ms (100 Hz < PRF < 1 KHz)

In this case, the signal is varying too slowly to be averaged in the front end of the sensor, so averaging must be performed after digitalization by increasing the averaging number in the power meter application (or calculating the average of several measurements if controlling the sensor over the bus). A large amount of averaging must be used for some pulse/pattern repetition frequencies to get a steady reading. If Low Aperture Time (LAT) mode is selected, the maximum recommended pulse repetition time is about 10 ms. If High Aperture Time (HAT) mode is selected, signals with pulse repetition periods as long as 50 ms can usually be measured.

Case 3: Modulated signals with pulse or pattern repetition times greater than 50 ms

In this case, it can be difficult to get an accurate average power reading even by averaging many readings. The sample rate of the sensor and the pulse repetition rate of the signal may be close enough that they can “beat” together resulting in low frequency modulation of the power indication. If averages are not calculated over many of these beats, or an integer number of beats, errors can result. This is not unique to the MA24106A and can be an issue with any power sensor/meter and any sampled data system.

High Crest Factor Signals (peak to average ratio)

High crest factor signals such as CDMA/WCDMA may have crest factors as high as 10 dB. To ensure the most accurate power measurement, the statistically low-probability peak signals should not exceed +30 dBm.

For example, if a signal has an expected crest factor of 10 dB, then the highest average power measured should not exceed +20 dBm. A sensor's linearity graph of a WCDMA (TestModel_5_8HSPDSCH) signal with 10 dB crest factor is shown below:

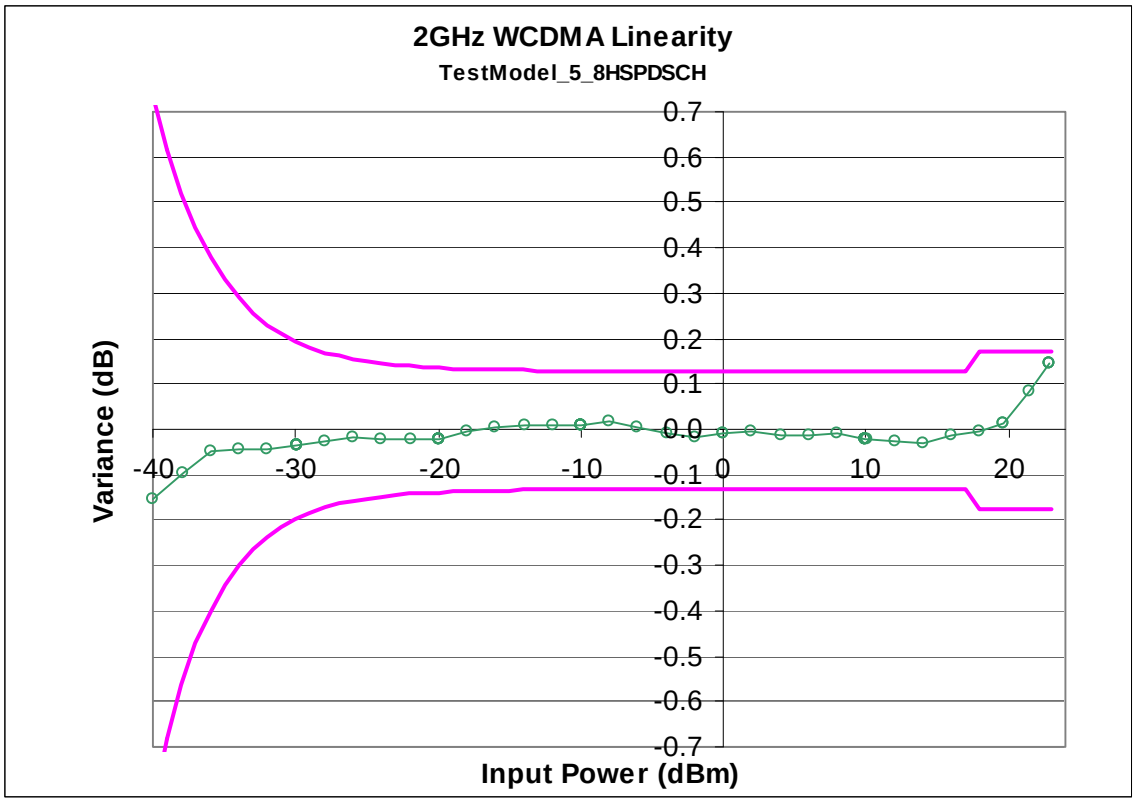


Figure 9-3. Sensor Linearity Graph

Multitone Signals

The MA24106A is a True-RMS sensor that can measure very wide bandwidth modulation without much restriction. The only limitation is the frequency flatness of the sensor. Because the sensor's sensitivity is not identical for all frequencies and when measuring multitone signals, the frequency entered into the sensor's application should be the average frequency of all significant tones. The MA24106A has an error of 0.01 dB for every 100 MHz bandwidth at frequencies below 3 GHz, and an error of 0.03 dB for every 100 MHz bandwidth at frequencies above 3 GHz.

For example, a dual tone signal of 2.0 GHz and 2.2 GHz may have an additional measurement error of 0.02 dB (0.01 dB × 2) when the application frequency is set to 2.1 GHz.

Noise and Averaging

When there is a need to achieve a required reading resolution, particularly at low power levels, averaging is often needed to reduce noise and steady the displayed power reading. Use the noise vs. resolution tables (Table 9-1 and Table 9-2 on page 9-4) to determine the number of averages that will typically be required for a given resolution. Alternatively, determine the number of averages through calculation by using the noise specifications and the fact that noise will be proportional to the square root of N, where N is the number of averages.

For example, a CW tone at –30 dBm is to be measured to 0.01 dB resolution. Using the table in the sensor manual, the required number of averages is 38 averages using High Aperture Time mode (the same measurement would require more than 256 averages in Low Aperture Time mode).

Settling Time

The MA24106A samples power continuously every 70 ms in the Low Aperture Time (LAT) mode and 700 ms in the High Aperture Time (HAT) mode. The sensor's front end and digitizer settles completely to a step change in power in this amount of time. However, there is no way to synchronize the sensor's sampling to any other event, such as a power step or bus request for a measurement. Therefore, the first measurement requested from the sensor after a power step may not be fully settled. To ensure a fully settled measurement when operating the sensor over the bus, wait 70 ms (700 ms if in HAT) after a power step before requesting the measurement from the sensor. Alternatively, request two measurements from the sensor and discard the first.

If averaging is required as described above, settling time increases by N × sample period, where N is the number of averages and the sample period is the time is milliseconds. The measurement sample period is 70 ms for LAT and 700 ms for HAT. When operating the sensor over the bus, request N+1 measurements from the sensor, discard the first, and then average the subsequent readings. The settling time is approximately (N+1) × sample period.

9-4 Uncertainty of a Measurement

Measurement Uncertainty Calculator

Included on the Power Expert CD-Rom is a Microsoft Excel tool for calculating power uncertainty. It is accessible from the Startup.htm page. It contains two tabs; one that provides measurement uncertainty for each sensor (selectable from a drop-down menu), and another tab that provides additional uncertainty components and calculated values for the MA24105A Peak Power Sensor.

Uncertainty Components

Power measurements have many component parts that affect overall measurement uncertainty when measuring power with the MA24106A sensor:

- **Sensor Linearity and Temperature Compensation:** Sensor Linearity and Temperature Compensation describe the relative power level response over the dynamic range of the sensor. Temperature Compensation should be considered when operating the sensor at other than room temperature.
- **Noise, Zero Set, and Zero Drift:** These are factors within the sensor that impact measurement accuracy at the bottom of the power sensor's dynamic range.
- **Mismatch Uncertainty:** Mismatch uncertainty is typically the largest component of measurement uncertainty. The error is caused by differing impedances between the power sensor and the device to which the power sensor is connected. Mismatch uncertainty can be calculated as follows:

  $$\% \text{ Mismatch Uncertainty} = 100\left[|1 + \Gamma_1\Gamma_2|^2 - 1\right]$$

  $$\text{dB Mismatch Uncertainty} = 10\log|1 + \Gamma_1\Gamma_2|$$

  where

  Γ_1 and Γ_2 are the reflection coefficients of the power sensor and the device under test
- **Sensor Calibration Factor Uncertainty:** Sensor Calibration Factor Uncertainty is defined as the accuracy of the sensor calibrated at a standard calibration condition. Anritsu follows the industry standard condition of calibration at a reference power of 0 dBm (1 mW) and an ambient temperature of 25 °C.

Uncertainty Example

Two measurement uncertainty calculations for Low Aperture Time mode are shown for the MA24106A in Table 9-3. The MA24106A is used to measure the power of a 3 GHz, +12.0 dBm and –35 dBm CW signal from a signal source with 1.5:1 VSWR. The example is based on 128 measurement averages.

Table 9-3. Measurement Uncertainty Example

Uncertainty Term	Uncertainty Specification at +12 dBm (%)	Uncertainty Specification at –35 dBm (%)	Probability Distribution	Divisor	Adjusted Uncertainty at +12 dBm (%)	Adjusted Uncertainty at –35 dBm (%)
Sensor Linearity (<+18 dBm)	3.0	3.0	Rectangular	√3	1.8	1.8
Noise	0.0	0.8	Normal at 2σ	2	0.0	0.4
Zero Set	0.0	3.2	Rectangular	√3	0.0	1.8
Zero Drift	0.0	0.9	Normal at 2σ	2	0.0	0.6
Calibration Factor Uncertainty	1.4	1.4	Normal at 2σ	2	0.7	0.7
Mismatch Uncertainty	4.0	4.0	Rectangular	√3	2.3	2.3
Combined Uncertainty (RSS), Room Temperature					3.0	3.6
Expanded Uncertainty with K=2, Room Temperature					6.0	7.2
Temperature Compensation	1.4	1.4	Rectangular	√3	0.8	0.8
Combined Uncertainty (RSS, 0 to 50 °C)					3.1	3.7
Expanded Uncertainty with K=2 (RSS, 0 to 50 °C)					6.2	7.4

Table 9-4. Noise Measurement Uncertainty Calculations

Noise Calculations at 12 dBm (16 mW):	
Noise	400 nW/16 mW = 0.0 %
Zero Set	1700 nW/16 mW = 0.0 %
Zero Drift	500 nW/16 mW = 0.0 %
Noise Calculations at –35 dBm (316 nW):	
Noise	2.5 nW/316 nW = 0.8 %
Zero Set	10 nW/316 nW = 3.2 %
Zero Drift	3 nW/316 nW = 0.9 %

9-5 Error States

This section details some of the error messages that may appear on the application screen. In most cases, the error condition can be easily corrected. The status LED will light yellow when an error state occurs. If not, note the error message and contact an Anritsu Service Center.

Table 9-5. Error Messages

Message	Description	Resolution
Zero invalid as temperature changed by more than 10 Degrees C	The sensor's ambient temperature has changed by more than 10 ºC since the last zero operation.	Perform the zero operation again.
Temperature out of operating range	Operating range of the sensor is 0 ºC to 55 ºC.	Re-examine the ambient conditions.
Sensor zero failed	This message box appears if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ZERO_ERROR	This message appears on the application screen if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
ADC_TEMP_OVERRNGE	This message appears on the application screen if the sensor is being operated in extremely high temperatures and has overheated.	Remove the sensor from the USB connection and allow to cool to the operating range of the sensor: 0 ºC to 55 ºC

Chapter 10 — Operational Testing for the MA24106A

10-1 Introduction

The test methodology and equipment described here can be used to gain some confidence in the measurement accuracy of the MA24106A Power Sensor. This is accomplished by comparing the sensor to another sensor with a specified cal factor and linearity performance or uncertainty. General commercially available equipment is used for these tests; however, these procedures are not sufficiently accurate to verify sensors to factory specification. Therefore, sensor test limits in these procedures are set appropriately to the specified comparison equipment. All tests should be performed at an ambient temperature of 20 ºC to 25 ºC.

Note	Calibration and verification of high accuracy power sensors requires substantial investment in both skill and equipment. For calibration, calibration verification, and to maintain the factory specifications of your power sensor, please send sensors to qualified Anritsu Customer Service Centers.

Refer to the following sections for required equipment and test procedures:

- “Required Equipment - MA24106A”
- “VSWR Pretest”
- “Frequency Response Test”
- “Linearity Test”

10-2 Precautions

Warning	**Do not** connect or apply power outside of the power sensor specifications or permanent damage may result.

Caution	**Before connecting the power sensor to another device, ensure the following:** Both connectors are in good condition and undamaged Pin depth is verified Both connectors are clean Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor. ESD precautions are observed. Refer to Chapter 4, “Power Sensor Care” for complete details. **When connecting the power sensor, ensure the following:** The connectors are aligned before mating Do not turn the connector body–only the connector coupling nut. Torque the connection using the correct torque wrench and proper torquing technique. Do not over torque. Refer to Chapter 4, “Power Sensor Care” for complete details.

10-3 Required Equipment - MA24106A

Table 10-1. Required Equipment

Equipment Description	Manufacturer and Model	Critical Specifications
Vector Network Analyzer (Pretest)	Anritsu MS4642A or equivalent	Reflection Coefficient Uncertainty ≤0.013, 10 MHz to 2 GHz Uncertainty ≤0.020, 2 GHz to 6 GHz
Synthesizer (Cal. Factor and Linearity Tests)	Anritsu MG3692 or equivalent	Output Power: >+18 dBm, 50 MHz to 6 GHz Output Power Setting Resolution: 0.01 dBm Harmonics: ≤–40 dBc Source VSWR ≤ 2.00
Reference Power Meter (Cal. Factor and Linearity Tests)	Anritsu ML2438 or equivalent	Instrumentation Accuracy ≤ 0.5 %
Reference Power Sensor (Cal. Factor and Linearity Tests)	Anritsu MA24002A or equivalent	NIST Calibration or equivalent
10 dB K Attenuator (Linearity Test)	Anritsu 41KC-10	VSWR ≤ 1.15, 10 MHz to 6 GHz
6 dB K Attenuator (Cal. Factor Test)	Anritsu 41KC-6	VSWR ≤ 1.15, 10 MHz to 6 GHz
Adapter N(f) to K(f) (Cal. Factor and Linearity Tests)	Anritsu 34ANF50 and 34AS50	VSWR ≤ 1.05, 10 MHz to 6 GHz
Power Splitter (Linearity Tests)	Anritsu K241B	Effective Output VSWR < 1.45, 10 MHz to 6 GHz
Personal Computer	Any	See Chapter 2

10-4 VSWR Pretest

The most common cause of power sensor failure is excess input power. Applying power exceeding the damage level shown on the label will damage the sensor's sensing element resulting in impedance change. Input match will be degraded when element impedance is changed. If you suspect that a senor is damaged, you should start with an input match pretest.

The maximum VSWR values are listed in the Performance Specification section of this manual. The uncertainty of the VSWR test equipment will affect actual measurement values. See Table 10-2 below for an example of how measurement system uncertainty can affect the Expected Maximum Reflection Coefficient when using the Anritsu MS4642A Vector Network Analyzer.

Test Procedure

Follow the manufacturers S_{11} (or return loss) calibration procedure to perform calibration on a network analyzer. Connect the power sensor to the network analyzer test port and measure power sensor input match. Typically, matches are measured in terms of return loss in dB. Return loss and magnitude of the reflection coefficient conversion equations are as follows:

$$\rho = 10^{-RL/20}$$

$$RL = -20\log\rho$$

where

RL = Return Loss in dB

ρ = Magnitude of the Reflection Coefficient

VSWR and magnitude of the reflection coefficient conversion equations are as follows:

$$VSWR = (1 + \rho) / (1 - \rho)$$

$$\rho = (VSWR - 1) / (VSWR + 1)$$

where

VSWR = Voltage Standing Wave Ratio

ρ = Magnitude of the Reflection Coefficient

Record the measured data into Table 10-2 under the Actual Measurement column. The Actual Measurement should be smaller than the Maximum Reflection coefficient. The Maximum Reflection Coefficient is equal to the measurement system uncertainty added to the sensor's reflection coefficient specification. If the Actual Measurement reflection coefficient is larger than the Maximum Reflection Coefficient, then the power sensor may be defective. If the actual reflection coefficient is significantly larger than the maximum values in Table 10-2, then the sensor is damaged and it is not necessary to perform further testing.

Note	There are no user-serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return defective sensors with a detailed description of the observed problem.

Table 10-2. Pretest Measurement Result

Frequency	MS4642A Reflection Coefficient Uncertainty	Maximum Reflection Coefficient	Actual Measurement
50 MHz to 2 GHz	0.013	0.050 + 0.013 = 0.063	
2 GHz to 6 GHz	0.020	0.100 + 0.020 = 0.120	

10-5 Frequency Response Test

In this test the frequency response of the sensor is tested at one low power level against a reference sensor of known measurement uncertainty. The reference sensor should be calibrated by a reputable standards laboratory using instruments with low published measurement uncertainty values. To perform the comparison, both sensors are used to measure the output power of a synthesizer with a high quality attenuator, such as the 41KC-6, on the output. The attenuator improves the source match of the synthesizer by lowering the mismatch ripples, thereby lowering the uncertainty in the comparison.

Test Procedure

1. Set up the equipment as follows (refer to Figure 10-1 for an illustration):

a. Connect the reference power sensor to the reference power meter using the appropriate cables.

b. Connect the MA24106A USB cable between the personal computer with the PowerXpert application installed and the MA24106A power sensor under test.

c. Launch the PowerXpert application.

d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in their respective manuals.

e. Reset or Preset all of the instruments.

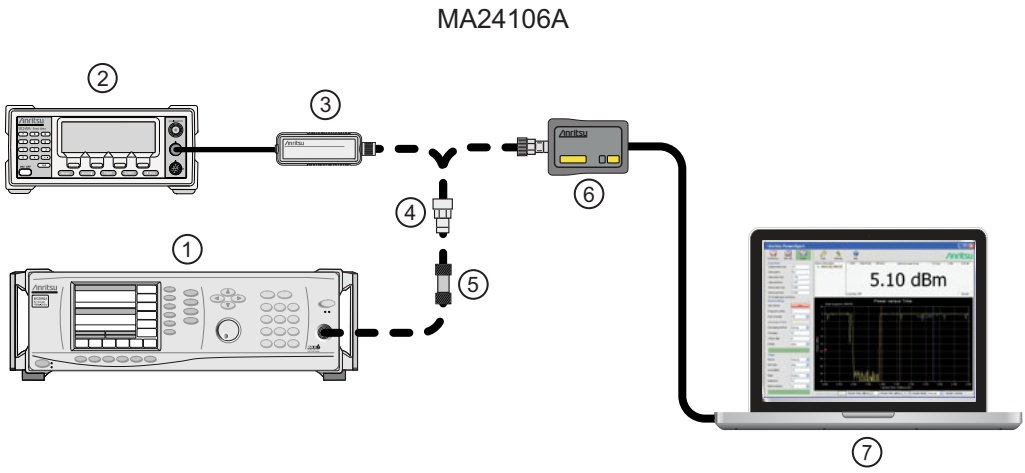
f. Configure the reference meter and sensor to measure a CW signal.

g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

h. Perform a low level Zero of the MA24106A by disconnecting the MA24106A from the synthesizer, clicking the **Zero** button on the PowerXpert application, and waiting for the Zeroing message to close.

i. Connect the attenuator to the output of the synthesizer, then connect the appropriate adapter to the output of the attenuator.

j. Set the synthesizer to +6 dBm and 50 MHz.



Index	Description
1	Synthesizer
2	Reference Power Meter
3	Reference Power Sensor
4	K to N Adapter

Figure 10-1. Cal Factor Test Set Up (1 of 2)

5	Attenuator
6	MA24106A Power Sensor
7	PC with Anritsu PowerXpert Application

Figure 10-1. Cal Factor Test Set Up (2 of 2)

2. Connect the reference sensor to the synthesizer with the appropriate adapter and attenuator in-line (see Figure 10-1).
3. Apply the Cal factor to the reference sensor per the manufacturer's instruction.
4. Record the power indicated by the reference meter in Table 10-3.
5. Disconnect the reference sensor from the synthesizer output and connect the MA24106A power sensor with the appropriate adapter and attenuator in-line (see Figure 10-1).
6. Apply the Cal factor to the MA24106A by entering the frequency (in GHz) in the PowerXpert application, and then click **Apply above settings**.
7. Record the power indicated by the MA24106A in Table 10-3.
8. Set the synthesizer frequency to the next frequency in Table 10-3.
9. Repeat Step 2 through Step 8 until all of the frequencies in Table 10-3 have been measured.
10. For each row in Table 10-3, calculate the absolute value of the difference between the recorded Reference power measurement and the recorded MA24106A measurement, and record the result in Table 10-3.
11. For each frequency, compare the power difference to the maximum allowed difference specified in Table 10-3. If the difference is higher than the maximum allowed difference, contact Anritsu customer service.

Table 10-3. Test Measurement Results

Frequency (GHz)	A Reference Power Measurement (dBm)	B MA24106A Measurement (dBm)	|A-B| Absolute Value of Difference in Power Measurements (dB)	Maximum Allowed Difference (dB)
0.05				0.26
0.1				0.26
0.3				0.26
0.5				0.26
1.0				0.26
2.0				0.31
3.0				0.31
4.0				0.31
5.0				0.33
6.0				0.33

10-6 Linearity Test

The linearity correction of the MA24106A is compared to a thermal power sensor, which has very good inherent linearity over a power range of about –20 to +10 dBm. For this reason, the MA24106A will be compared to the thermal sensor in two *ranges*, keeping the power levels to the thermal sensor in the range of –17 dBm to +5 dBm, while the power to the MA24106A will vary from about –26 dBm to about +14 dBm.

Test Procedure

1. Set up the equipment as follows (refer to Figure 10-2 for an illustration):

a. Connect the reference power sensor to the reference power meter using the appropriate cables.

b. Connect the USB cable between the personal computer with the PowerXpert application installed and the MA24106A power sensor under test.

c. Launch the PowerXpert application.

d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in the instrument's respective manuals.

e. Reset or Preset all of the instruments.

f. Configure the reference meter and sensor to measure a CW signal.

g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

h. Perform a low-level Zero of the MA24106A by disconnecting the sensor from the synthesizer, click the **Zero** button in the PowerXpert application, and wait for the Zeroing message to close.

i. Connect the power splitter to the output of the synthesizer and connect the 10 dB attenuator to one of the splitter outputs.

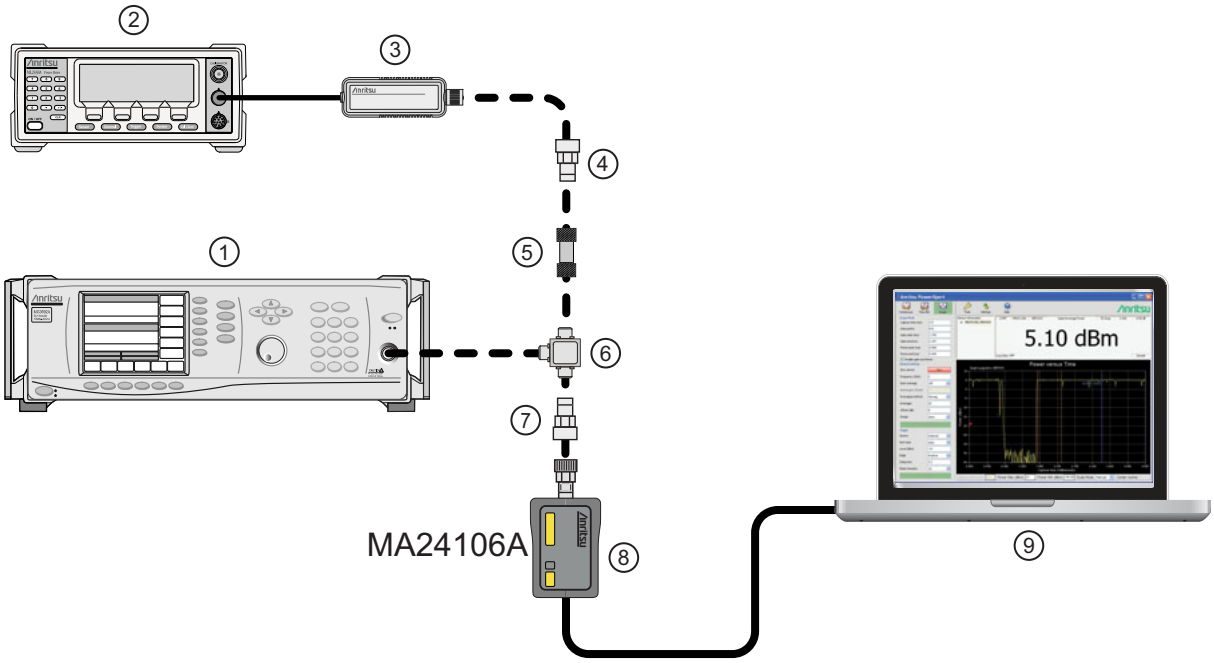
j. Connect an N(f) to K adapter to each power sensor.

k. Connect the reference sensor and adapter to the 10 dB attenuator.

l. Connect the MA24106A and adapter to the other splitter output.

m. Set the synthesizer to 50 MHz and +20 dBm.

n. Increase averaging by entering "16" in the PowerXpert application, and then click **Apply above settings**.



Index	Description
1	Synthesizer
2	Reference Power Meter
3	Reference Power Sensor
4	K to N Adapter (if required)
5	Attenuator
6	Power Splitter
7	K to N Adapter (if required)
8	MA24106A Power Sensor
9	PC with Anritsu PowerXpert Application

Figure 10-2. Linearity Test Setup 1

2. Apply the Cal factor to the reference sensor per the manufacturer's procedure.

3. Apply the Cal factor to the MA24106A by entering the frequency (in GHz) in the PowerXpert application, and then click **Apply above settings**.

4. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24106A.

5. Turn On the synthesizer's RF output.

6. Record data for the first 20 dB range as follows:

a. Record the power reading by the reference meter in Table 10-4 on page 10-9.

b. Record the power reading by the MA24106A in Table 10-4.

c. Set the synthesizer power to +15 dBm.

d. Record the reference meter and the MA24106A power sensor readings in Table 10-4.

e. Repeat the measurement for synthesizer output levels of +10, +5, and 0 dBm.

Note The MA24106A power measured at 0 dBm will be used in Step 7e, below.

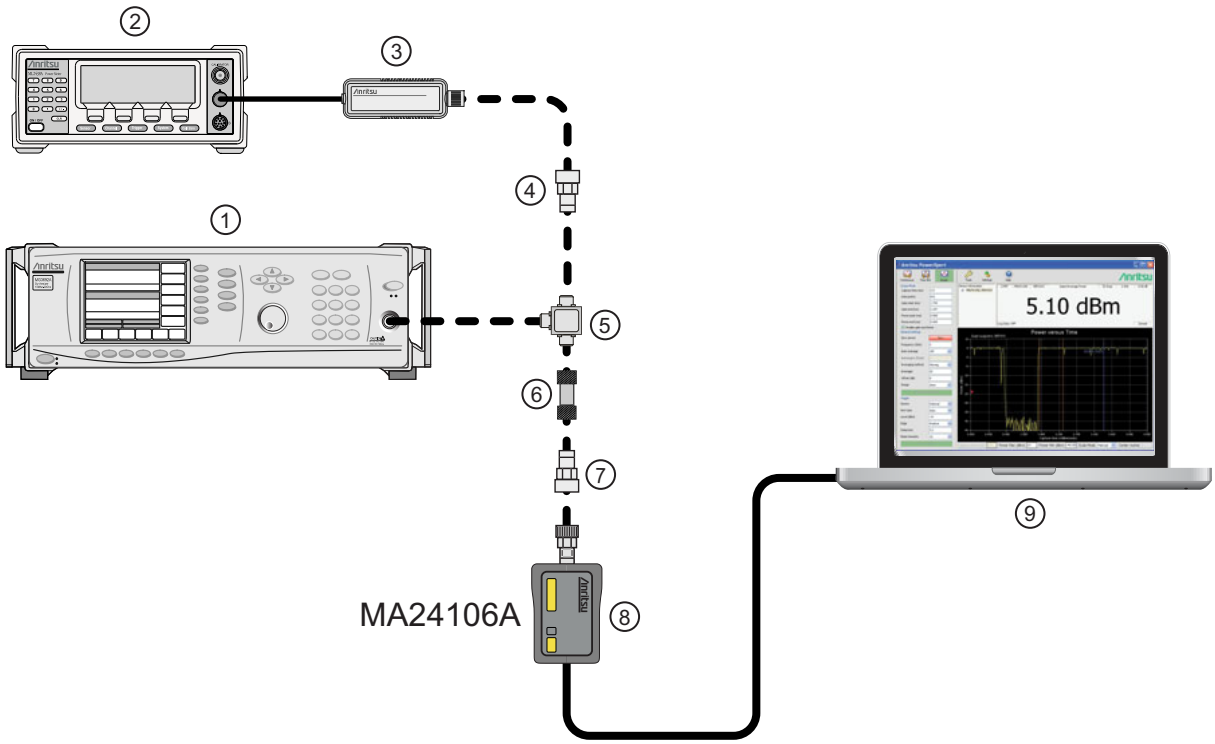
7. Set up the test for the second 20 dB range as follows:

a. Remove the 10 dB attenuator from in between the reference sensor and splitter and connect the reference sensor directly to the splitter.

b. Remove the MA24106A from the splitter and connect the 10 dB attenuator between the splitter and the MA24106A power sensor (see Figure 10-3).

c. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24106A.

d. Turn On the synthesizer's RF output.



Index	Description
1	Synthesizer
2	Reference Power Meter
3	Reference Power Sensor
4	K to N Adapter (if required)
5	Power Splitter
6	Attenuator
7	K to N Adapter (if required)
8	MA24106A Power Sensor
9	PC with Anritsu PowerXpert Application

Figure 10-3. Linearity Test Setup 2

e. Set the synthesizer output level to +10 dBm and then adjust it until the sensor/meter under test reads as close as possible to the value obtained above in Step 6e.

8. Record data for the next 20 dB range

a. Read and record the power indicated by the reference meter in Table 10-4.

b. Lower the output power level of the synthesizer to +5 dBm.

c. Record the reference meter and the MA24106A power sensor readings in Table 10-4.

d. Repeat the measurement for synthesizer output levels of 0, –5, and –10 dBm.

Table 10-4. Measurement Results (50 MHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	-5	0		0		10		
10	-10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

9. Perform the calculations and operation check as follows:

a. Subtract the Reference Power Measurement of row 5 from the Reference Power Measurement of row 6. Record this value in the Correction column of rows 1 through 5.

Note	The Correction column of rows 1 through 5 should all have the same value. The Correction column of rows 6 through 10 have values of 0.

b. Add the Reference Power Measurement and Correction values of row 1 and record the result in the Corrected Reference Power Measurement column of row 1.

c. Repeat Step 9b for rows 2 through 10.

d. Subtract the MA24106A Measurement of row 1 from the Corrected Reference Power Measurement of row 1 and record the result in the Difference Calculation column of row 1.

e. Repeat Step 9d for rows 2 through 10.

f. Find the largest (most positive) value in the Difference Calculation column and record this value next to the word Max in row 11.

g. Find the smallest (least positive or most negative) value in the Difference Calculation column and record this value next to the word Min in row 12.

h. Subtract the Min value from Step 9g from the Max value from Step 9f and record the result next to the word Delta in row 13.

i. The Delta result should be less than 0.3 dB. If it is larger, contact Anritsu customer service.

10. Repeat the entire measurement and calculations with synthesizer frequency settings of 2 GHz, 4 GHz, and 6 GHz.

Table 10-5. Measurement Results (2 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	C–D Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 10-6. Measurement Results (4 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 10-7. Measurement Results (6 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA24106A Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Chapter 11 — Using the MA24108A, MA24118A, and MA24126A

11-1 Sensor Overview

The MA24108A, MA24118A, and MA24126A power sensor is illustrated in the figure below:

Index	Description
1	RF Input: N Type Connector (Torque connector at 12 lbf·in (1.35 N·m) RF Input (MA24126A): K Type Connector (Torque connector at 8 lbf·in (0.90 N·m)
2	2-color LED (reports functional status of the sensor) **Green:** Sensor ON, Status OK **Amber:** Error or Programming Condition
3	USB Micro-B Port (for connection with a PC or Anritsu handheld instrument)
4	External Trigger Input (TTL/CMOS)

Figure 11-1. MA24108A, MA24118A, and MA24126A Sensor Overview

11-2 Making Measurements

This section presents common procedures for using the MA24108A, MA24118A, and MA24126A power sensors with a PC. These procedures refer to the power sensor and to the Anritsu PowerXpert PC application buttons and menus that were previously described. Before attempting these procedures, you should be familiar with the Anritsu PowerXpert PC application. If an Anritsu Master™ series handheld instrument is being used with the power sensor, refer to the user documentation that came with the handheld instrument for procedures on operating external power sensors.

Basic Power Measurement

1. Connect the sensor to a computer or Anritsu Master™ series instrument as shown in Figure 11-2.
2. Open the Anritsu PowerXpert application.
3. Zero the sensor as described below in "Zeroing the Sensor".

Warning	**Do not** connect or apply power outside of the power sensor specifications or permanent damage may result.

Caution

Before connecting the power sensor to another device, ensure the following:

Both connectors are in good condition and undamaged
Pin depth is verified
Both connectors are clean
Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor.
ESD precautions are observed.
Refer to Chapter 4, “Power Sensor Care” for complete details.

When connecting the power sensor, ensure the following:

The connectors are aligned before mating
Do not turn the connector body–only the connector coupling nut.
Torque the connection using the correct torque wrench and proper torquing technique.
Do not over torque.
Refer to Chapter 4, “Power Sensor Care” for complete details.

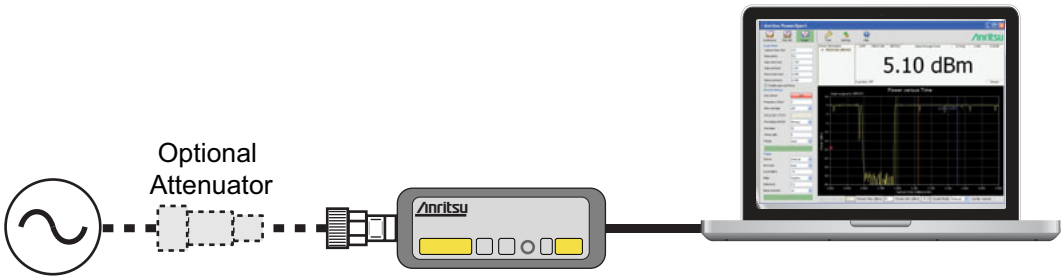


Figure 11-2. Measurement Setup

4. Connect the RF source to the RF IN port of the power sensor. An attenuator is necessary for measuring power levels above +20 dBm.
5. Read the power measurement from the Anritsu PowerXpert application window (power readings are continuous with the default setting).

Connecting the DUT

RF signal connections are made to the male RF connector, which has a 50 ohm characteristic impedance. When connecting to the male connector of the sensor, observe the following practice for tightening the connection:

1. While holding the body of the sensor in one hand, turn the male connector nut to finger tighten the connection. **Do not** turn the body of the sensor as this will cause excessive wear to the connector.
2. Back off the connection by turning the connector nut counter clockwise 1/4 turn.
3. Tighten the connection (clockwise) using a 12 in-lb torque wrench (Anritsu part number: 01-200).

Zeroing the Sensor

Zero the sensor before making power measurements. If frequent low-level measurements are being made, it is advised to check the sensor zeroing often and repeat as necessary. If the sensor goes into sleep mode, the sensor must be re-zeroed before taking measurements. Before zeroing the sensor, connect it to the DUT (device under test) test port and remove RF power from the connection to a level 20 dB below the noise floor of the power sensor. For the power sensors, this level is less than –60 dBm. It is preferable to leave the sensor connected to the DUT test port so that ground noise and thermal EMF (electro-magnetic fields) are zeroed out of the measurement. The sensor may also be connected to a grounded connector on the DUT or disconnected from any signal source.

To zero the sensor, click the **Zero** button on the application. If the sensor fails the zeroing operation, the messages "Range 1 zeroing error" and/or "Range 2 zeroing error" is displayed on the application screen until the problem is corrected.

Calibrating the Sensor

The signal channel/analog signal acquisition hardware is integrated along with the RF front end of the power sensor. All calibration factors, as well as linearity and temperature corrections, are stored in the sensor. Therefore, there is no need for a reference calibration with the sensor.

Applying a Calibration Factor Correction

The power sensor has an internal EEPROM containing correction and calibration factors that were programmed into the sensor at the factory. The power sensor has an internal temperature sensor that reports its readings periodically to the microprocessor. The sensor makes all of the required calculations on the measurement once the measurement frequency has been entered in the General Settings area.

Optimizing the Readings

This section presents information on how to get the fastest readings from the power sensor when using the Anritsu PowerXpert application or operating under remote control (refer to Chapter 13, "Remote Operation" for specific remote programming command descriptions). Measurement speed depends greatly on the type of measurement, the power level, and stability of the signal. Stability of a measurement is influenced by noise and signal modulation. If high resolution is required, averaging must be increased.

Table 11-1 on page 11-4 describes the number of averages needed to attain a certain noise level for a particular power level measurement.

Note	The values in the following table are typical and should be used as a reference only.

Table 11-1. Sensor Averaging Table (Continuous Mode, default settings, 20 ms aperture time)

Input Power (dBm)	Input Power (mW)	Number of Averages Needed for < ±0.20 dB Noise	Number of Averages Needed for < ±0.15 dB Noise	Number of Averages Needed for < ±0.10 dB Noise	Number of Averages Needed for < ±0.05 dB Noise	Number of Averages Needed for < ±0.01 dB Noise
20	100.0000000	1	1	1	1	1
15	31.6000000	1	1	1	1	1
10	10.0000000	1	1	1	1	1
5	3.2000000	1	1	1	1	1
0	1.0000000	1	1	1	1	1
–5	0.3160000	1	1	2	5	122
–10	0.1000000	1	1	1	1	1
–15	0.0316000	1	1	1	1	1
–20	0.0100000	1	1	1	1	4
–25	0.0031600	1	1	1	2	31
–30	0.0010000	1	2	4	13	303
–35	0.0003160	8	14	31	123	3028
–40	0.0000100	79	139	309	1222	30278

Noise Calculations:

$$20dBm \le Power \le -7dBm$$

$$\pm noise(dB) = -10\log\left[1-\left(\frac{40\times10^{-6}}{10^{\left(Power/10\right)}}\right)\left(\frac{20\times Points}{Time\times N}\right)^{1/2}\right]$$

$$-40dBm < Power < -7dBm$$

$$\pm noise(dB) = -10\log\left[1-\left(\frac{8\times10^{-3}}{10^{\left(Power/10\right)}}\right)\left(\frac{20\times Points}{Time\times N}\right)^{1/2}\right]$$

where:

Continuous Average Mode:

Power = Power level being measured in dBm
Points = 1
Time = Aperture time in milliseconds
N = Number of averages

Scope Mode:

Power = Power level being measured in dBm
Points = The number of data points on the scope graph
Time = Capture time in milliseconds
N = Number of averages

11-3 Measurement Considerations

High Crest Factor Signals (peak to average ratio)

High crest factor signals, such as CDMA/WCDMA, may have crest factors as high as 10 dB. To ensure the most accurate power measurement, the statistically-low peak signals should not exceed +30 dBm.

For example, if a signal has an expected crest factor of 10 dB, then the highest average power measured should not exceed +20 dBm. A sensor's linearity graph of a WCDMA (TestModel_5_8HSPDSCH) signal with 10 dB crest factor is shown below:

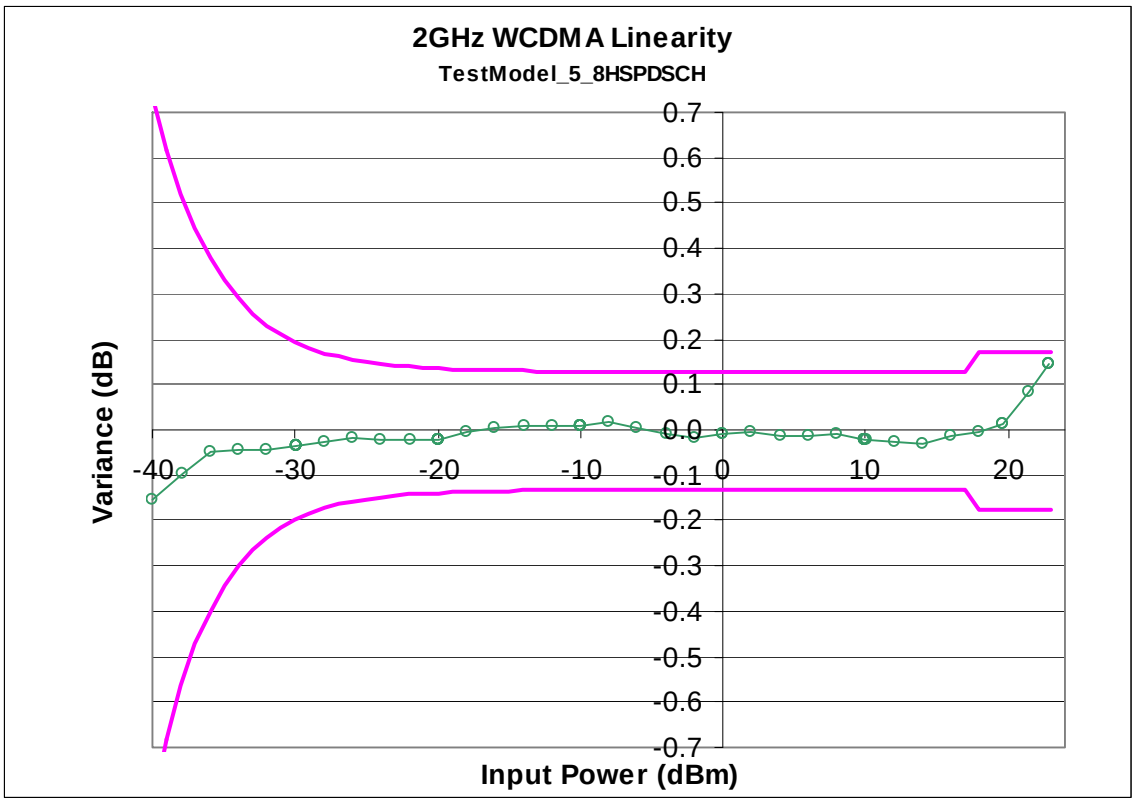


Figure 11-3. Sensor Linearity Graph

Multitone Signals

The sensor is a True-RMS sensor that can measure very wide bandwidth modulation without much restriction. The only limitation is the frequency flatness of the sensor. Because the sensor's sensitivity is not identical for all frequencies and when measuring multitone signals, the frequency entered into the sensor's application should be the average frequency of all significant tones. The sensor has an additional uncertainty of 0.05 dB for every 1 GHz tone separation when measuring multitone signals.

For example, a dual tone signal of 2 GHz and 4 GHz may have an additional measurement error of 0.1 dB (0.05 dB × 2) when the application frequency is set to 3 GHz.

Noise and Averaging

When there is a need to achieve a required reading resolution, particularly at low power levels, averaging is often needed to reduce noise and steady the displayed power reading. Use the noise vs. resolution table in "Optimizing the Readings" on page 11-3 to determine the number of averages that will typically be required for a given resolution. Alternatively, determine the number of averages through calculation by using the noise specifications and the fact that noise will be proportional to the square root of N, where N is the number of averages. For example, a CW tone at –25 dBm is to be measured to 0.05 dB resolution. Using Table 3-7, the required number of averages is 2 averages. The same measurement to 0.01 dB resolution would require 31 averages.

Average Value of Time Varying Signals

When measuring the average Power of a time varying or modulated signal with a modulation rate which is much greater than the signal channel BW of the sensor, averaging of the power is performed in the sensor hardware (detectors and or preamplifiers). For the case of the MA24108A / MA24118A the signal channel BW is 50 KHz, so signals modulated at MHz rates will be averaged in the hardware, and no special considerations are required.

When measuring signals with modulation frequency components near, or below, the signal channel bandwidth, average power readings may be seen to fluctuate over time. This fluctuation may be reduced through careful selection of the aperture time and averaging number. Ideally, the aperture time should be chosen to be an integer multiple of the modulation frequency. If this can be done, then the average power reading will be stable for each measurement update. For modulations with multiple frequencies present, or with significant modulation components with periods longer than the maximum 300 ms aperture time, averaging will have to be increased to obtain a stable reading. If the measurement update rate is very close to the period of the modulation, a low frequency "beat note" can result. If the frequencies are very close, the beat note can be very low in frequency, and therefore require very long averaging times to remove. In this case it is suggested that the aperture time be changed to result in a higher frequency beat which is easier to average out.

Settling Time

The signal channel bandwidth of the power sensor supports a rise time of about 8 us. The ADC sample period is a bit more than 7 us. Thus it will take more than one ADC sample for the signal channel hardware to completely settle in response to a step change in input power. The hardware settling time can be estimated by assuming a single pole response with the 50 kHz bandwidth:

$$Settlingtime = -\left[\tau \times \ln\left(\frac{SP}{100}\right)\right]$$

where:

$$\tau = \frac{0.35}{(50e-3)} = 7e-6\,\text{sec}\,onds$$

$$SP = Desired\ Settling\ \%$$

For small settling percentages, it is quite likely that the noise per ADC sample will be larger than the desired settling percentage, thus averaging or decimation of ADC samples will have to be used to reduce the noise. Averaging will, of course, increase the settling time of the measurement in direct proportion to the averaging number used.

It is important to note that the settling time described above strictly applies only to increasing power steps (rise time). Settling to decreasing power steps is typically slower. For settling decreasing power steps to 1 % or 0.1 %, the settling will typically be within a factor of 2 or 3 of the calculation above. Settling to 0.01 % or less may take considerably longer.

Noise and Time Resolution in Scope Mode

In scope mode (and in all other modes) the MA24108A / MA24118A is sampling at full speed, which is about once every 7 µs. When the period chosen for scope mode exceeds the number of data points times this period, then multiple ADC samples are averaged to form each data point. Therefore there is a trade-off between time resolution (many data points) and trace noise. To minimize trace noise, choose less data points. Of course for recurrent waveforms trace averaging can always be used to reduce trace noise if a large number of points is desired. This would however tend to increase the over-all measurement time.

Optimizing Internal Triggering

Sometimes it can be difficult to obtain consistent triggering in scope or slot mode. Here are some points to consider when choosing triggering parameters:

- It is more difficult to trigger on signals which are slowly varying with time. Noise in the signal channel can result in false triggers. In this case, try setting the trigger level at powers away from the bottoms of the measurement ranges. The trigger crossover power is about +2 dBm. Thus it can be advantageous to avoid setting the trigger at powers just above +2 dBm, and powers just above -20 dBm where the trigger signal is noisy.
- Modulated signals can appear “noisy” and also result in false triggers. In this case adjusting the trigger level may not help. Sometimes there may be a portion of the signal with less modulation, or less “noise-like” modulation which can be triggered on with more success. Try using a different trigger point and adjusting the trigger delay to shift the waveform in time to see the desired section.
- False triggers due to either noise or noise-like modulation can be reduced by increasing the trigger noise immunity parameter. This will result in a slight positive trigger delay, but this can be made up for by introducing a negative trigger delay with the trigger delay parameter.
- The trigger settings should always be optimized before trace averaging is applied. If trace averaging is used when the trigger is not stabilized, the displayed waveform will not be an accurate representation of the signal. First optimize the trigger, then apply trace averaging.

Noise Floor in Scope Mode

The noise level or “floor” displayed in scope or slot mode in PowerXpert when using low averaging may seem to be higher than what would be expected. This is due to the way noise is dealt with when converting power into dBm for display. With no input power, the values of the ADC samples vary about some value which corresponds to zero power. Ideally there are equal number of samples above and below this value. The samples which are below this value correspond to “negative” power. This is non-physical, and does not truly mean there is negative power flow to the sensor, it is simply a by product of noise in the signal channel. If these samples are displayed in linear power units such as mW, then the noise floor will be as expected. However there is a problem when converting to logarithmic units such as dB. Because taking the logarithm of negative numbers is not generally allowed, the absolute value of the samples is usually taken before taking the logarithm. This has the drawback of increasing the average value of the samples, artificially increasing the apparent noise floor. When the averaging is increased, the noise floor will go down. The apparent noise floor can be estimated using:

$$NF = 0.8 \times noise$$

where:

NF = the average linear power or noise floor due to taking absolute value of power samples

$noise$ = the noise power in linear units on a 1 sigma basis

11-4 Uncertainty of a Measurement

Measurement Uncertainty Calculator

Included on the Power Expert CD-Rom is a Microsoft Excel tool for calculating power uncertainty. It is accessible from the Startup.htm page. It contains two tabs; one that provides measurement uncertainty for each sensor (selectable from a drop-down menu), and another tab that provides additional uncertainty components and calculated values for the MA24105A Peak Power Sensor.

Uncertainty Components

Power measurements have many component parts that affect overall measurement uncertainty when measuring power with the power sensor:

- **Measurement Uncertainty:** Measurement uncertainty includes the uncertainty associated with the correction of frequency and the linearity response of the sensor over the entire dynamic range. Anritsu follows the industry standard condition of calibrating the power-sensing element at a reference power of 0 dBm (1 mW) and an ambient temperature of 25 °C.
- **Temperature Compensation:** Sensor Temperature Compensation describes the relative power level response over the dynamic range of the sensor. Temperature Compensation should be considered when operating the sensor at other than room temperature.
- **Noise, Zero Set, and Zero Drift:** These are factors within the sensor that impact measurement accuracy at the bottom of the power sensor's dynamic range.
- **Mismatch Uncertainty:** Mismatch uncertainty is typically the largest component of measurement uncertainty. The error is caused by the differing impedances between the power sensor and the devices to which the power sensor is connected. Mismatch uncertainty can be calculated as follows:

  $$\% \text{ Mismatch Uncertainty} = 100[|1 + \Gamma_1\Gamma_2|^2 - 1]$$

  $$\text{dB Mismatch Uncertainty} = 20\log|1 + \Gamma_1\Gamma_2|$$

  where:

  Γ_1 is the reflection coefficient of the power sensor

  Γ_2 is the reflection coefficient of the device

Uncertainty examples are shown in Table 11-2 on page 11-9 and Table 11-3 on page 11-10.

Uncertainty Examples

Two measurement uncertainty calculations are shown for the MA24108A and MA24118A sensors in Table 11-2. The power sensor is used to measure the power of a 3 GHz, +12.0 dBm and –35 dBm CW signal from a signal source with a 1.5:1 VSWR. The example is based on an aperture time of 20 ms and 64 measurement averages.

Table 11-2. MA24108A and MA24118A Measurement Uncertainty Example

Uncertainty Term	Uncertainty Specification at +12 dBm (%)	Uncertainty Specification at –35 dBm (%)	Probability Distribution	Divisor	Adjusted Uncertainty at +12 dBm (%)	Adjusted Uncertainty at –35 dBm (%)
Sensor Linearity (<+18 dBm)	3.0	3.0	Rectangular	√3	1.7	1.7
Noise	0.0	1.6	Normal at 2σ	2	0.0	0.8
Zero Set	0.0	3.2	Rectangular	√3	0.0	1.8
Zero Drift	0.0	0.9	Normal at 2σ	2	0.0	0.6
Calibration Factor Uncertainty	1.5	1.5	Normal at 2σ	2	0.8	0.8
Mismatch Uncertainty	4.0	4.0	Rectangular	√3	2.3	2.3
Combined Uncertainty (RSS), Room Temperature					3.0	3.6
Expanded Uncertainty with K=2, Room Temperature					6.0	7.3
Temperature Compensation	1.4	1.4	Rectangular	√3	0.8	0.8
Combined Uncertainty (RSS, 0 to 50 °C)					3.1	3.6
Expanded Uncertainty with K=2 (RSS, 0 to 50 °C)					6.2	7.5

Two measurement uncertainty calculations are shown for the MA24126A sensor in Table 11-3. The power sensor is used to measure the power of a 3 GHz, +12.0 dBm and –35 dBm CW signal from a signal source with a 1.5:1 VSWR. The example is based on an aperture time of 20 ms and 64 measurement averages.

Table 11-3. MA24126A Measurement Uncertainty Example

Uncertainty Term	Uncertainty Specification at +12 dBm (%)	Uncertainty Specification at –35 dBm (%)	Probability Distribution	Divisor	Adjusted Uncertainty at +12 dBm (%)	Adjusted Uncertainty at –35 dBm (%)
Sensor Linearity (<+18 dBm)	3.0	3.0	Rectangular	√3	1.7	1.7
Noise	0.0	1.6	Normal at 2σ	2	0.0	0.8
Zero Set	0.0	3.2	Rectangular	√3	0.0	1.8
Zero Drift	0.0	0.9	Normal at 2σ	2	0.0	0.6
Calibration Factor Uncertainty	2.5	2.5	Normal at 2σ	2	1.25	1.25
Mismatch Uncertainty	4.0	4.0	Rectangular	√3	2.3	2.3
Combined Uncertainty (RSS), Room Temperature					3.2	3.8
Expanded Uncertainty with K=2, Room Temperature					6.3	7.6
Temperature Compensation	1.4	1.4	Rectangular	√3	0.8	0.8
Combined Uncertainty (RSS, 0 to 50 °C)					3.3	3.9
Expanded Uncertainty with K=2 (RSS, 0 to 50 °C)					6.5	7.7

Table 11-4. Noise Measurement Uncertainty Calculations

Noise Calculations at 12 dBm (16 mW):	
Noise	1 µW/16 mW = 0.0 %
Zero Set	1 µW/16 mW = 0.0 %
Zero Drift	0.5 µW/16 mW = 0.0 %
Noise Calculations at –35 dBm (316 nW):	
Noise	5 nW/316 nW = 1.6 %
Zero Set	10 nW/316 nW = 3.2 %
Zero Drift	3 nW/316 nW = 0.9 %

11-5 Error States

This section details some of the error messages that may appear on the application screen. In most cases, the error condition can be easily corrected. The status LED will light amber when an error state occurs. If not, note the error message and contact an Anritsu Service Center.

Table 11-5. Error Messages

Message	Description	Resolution
Temp change > 10 C	The sensor's ambient temperature has changed by more than 10 ºC since the last zero operation.	Perform the zero operation again.
Temperature over range	The sensor is operating outside of its specified range of 0 ºC to 55 ºC.	Operate the sensor within its specified range.
Range 1 zero failure or Range 2 zero failure	This message appears if the zero operation is unsuccessful. The reason could be the presence of RF power at the input of the sensor.	Turn off the RF input to the sensor or disconnect the sensor from the RF source and try the zero operation again.
Range 1 over range	This message appears on the application screen if excess power is applied to the sensor.	Reduce the input power to the sensor to within acceptable limits (< 30 dBm).

Chapter 12 — Operational Testing for the MA24108A, MA24118A, and MA24126A

12-1 Introduction

The test methodology and equipment described here can be used to gain some confidence in the measurement accuracy of the MA24108A, MA24118A, or MA24126A Power Sensor. This is accomplished by comparing the sensor to another sensor with a specified cal factor and linearity performance or uncertainty. General commercially available equipment is used for these tests; however, these procedures are not sufficiently accurate to verify sensors to factory specification. Therefore, sensor test limits in these procedures are set appropriately to the specified comparison equipment. All tests should be performed at an ambient temperature of 20 ºC to 25 ºC.

Note	Calibration and verification of high accuracy power sensors requires substantial investment in both skill and equipment. For calibration, calibration verification, and to maintain the factory specifications of your power sensor, please send sensors to qualified Anritsu Customer Service Centers.

Refer to the following sections for required equipment and test procedures:

- “Required Equipment - MA24108A/118A/126A”
- “VSWR Pretest”
- “Frequency Response Test”
- “Linearity Test”

12-2 Precautions

Warning	**Do not** connect or apply power outside of the power sensor specifications or permanent damage may result.

Caution	**Before connecting the power sensor to another device, ensure the following:** Both connectors are in good condition and undamaged Pin depth is verified Both connectors are clean Ensure the output of the device you are connecting to does not exceed the signal limits of the sensor. ESD precautions are observed. Refer to Chapter 4, “Power Sensor Care” for complete details. **When connecting the power sensor, ensure the following:** The connectors are aligned before mating Do not turn the connector body–only the connector coupling nut. Torque the connection using the correct torque wrench and proper torquing technique. Do not over torque. Refer to Chapter 4, “Power Sensor Care” for complete details.

12-3 Required Equipment - MA24108A/118A/126A

Table 12-1. Required Equipment

Equipment Description	Manufacturer and Model	Critical Specifications
Vector Network Analyzer (Pretest)	Anritsu 37369D Anritsu MS4642A or MS4644A (for MA24126A) or equivalent	Reflection Coefficient Uncertainty ≤ 0.013, 10 MHz to 2 GHz Uncertainty ≤ 0.020, 2 GHz to 18 GHz Uncertainty ≤ 0.025, 18 GHz to 26 GHz
Synthesizer (Cal. Factor and Linearity Tests)	Anritsu MG3693 or equivalent	Output Power: > +10 dBm, 50 MHz to 26 GHz Output Power Setting Resolution: 0.01 dBm Harmonics: ≤ –40 dBc Source VSWR ≤ 2.00
Reference Power Meter (Cal. Factor and Linearity Tests)	Anritsu ML2438A or equivalent	Instrumentation Accuracy ≤ 0.5 %
Reference Power Sensor (Cal. Factor and Linearity Tests)	Anritsu MA24002A or equivalent, or Anritsu MA24004A or equivalent (for MA24126A)	NIST Calibration or equivalent
10 dB K Attenuator (Linearity Test)	Anritsu 41KC-10	VSWR ≤ 1.15, 10 MHz to 12 GHz VSWR ≤ 1.20, 12 GHz to 18 GHz VSWR ≤ 1.30, 18 GHz to 26 GHz
6 dB K Attenuator (Cal. Factor Test)	Anritsu 41KC-6	VSWR ≤ 1.15, 10 MHz to 12 GHz VSWR ≤ 1.20, 12 GHz to 18 GHz VSWR ≤ 1.30, 18 GHz to 26 GHz
Adapter N(f) to K(f) (Cal. Factor and Linearity Tests)	Anritsu 34ANF50 and 34AK50	VSWR ≤ 1.10, 10 MHz to 18 GHz VSWR ≤ 1.17, 18 GHz to 26 GHz
Power Splitter (Linearity Tests)	Anritsu K241B	Effective Output VSWR < 1.45, 10 MHz to 26 GHz
Personal Computer	Any	See Chapter 2

12-4 VSWR Pretest

The most common cause of power sensor failure is excess input power. Applying power exceeding the damage level shown on the label will damage the sensor's sensing element resulting in impedance change. Input match will be degraded when element impedance is changed. If you suspect that a sensor is damaged, you should start with an input match pretest.

The maximum VSWR values are listed in the Performance Specification section of this manual. The uncertainty of the VSWR test equipment will affect actual measurement values. See the following Table 12-2 for an example of how measurement system uncertainty can affect the Expected Maximum Reflection Coefficient when using the Anritsu MS4642A Vector Network Analyzer.

Test Procedure

Follow the manufacturers S_{11} (or return loss) calibration procedure to perform calibration on a network analyzer. Connect the power sensor to the network analyzer test port and measure power sensor input match. Typically, matches are measured in terms of return loss in dB. Return loss and magnitude of the reflection coefficient conversion equations are as follows:

$$\rho = 10^{-RL/20}$$

$$RL = -20\log\rho$$

where

RL = Return Loss in dB

ρ = Magnitude of the Reflection Coefficient

VSWR and magnitude of the reflection coefficient conversion equations are as follows:

$$VSWR = (1 + \rho) / (1 - \rho)$$

$$\rho = (VSWR - 1) / (VSWR + 1)$$

where

VSWR = Voltage Standing Wave Ratio

ρ = Magnitude of the Reflection Coefficient

Record the measured data into Table 12-2 under the Actual Measurement column. The Actual Measurement should be smaller than the Maximum Reflection coefficient. The Maximum Reflection Coefficient is equal to the measurement system uncertainty added to the sensor's reflection coefficient specification. If the Actual Measurement reflection coefficient is larger than the Maximum Reflection Coefficient, then the power sensor may be defective. If the actual reflection coefficient is significantly larger than the maximum values in Table 12-2, then the sensor is damaged and it is not necessary to perform further testing.

Note	There are no user-serviceable parts inside the power sensors. Contact your local Anritsu Service Center and return defective sensors with a detailed description of the observed problem.

Table 12-2. Pretest Measurement Result

Frequency	37369D and MS4624B Reflection Coefficient Uncertainty	Maximum Reflection Coefficient	Actual Measurement
10 MHz to 50 MHz	0.013	0.310 + 0.013 = 0.323	
50 MHz to 150 MHz	0.013	0.078 + 0.013 = 0.091	
150 MHz to 2 GHz	0.013	0.057 + 0.013 = 0.070	
2 GHz to 12 GHz	0.020	0.099 + 0.020 = 0.119	
12 GHz to 18 GHz	0.020	0.111 + 0.020 = 0.131	
18 GHz to 26 GHz	0.025	0.149 + 0.025 = 0.174	

12-5 Frequency Response Test

In this test the frequency response of the sensor is tested at one low power level against a reference sensor of known measurement uncertainty. The reference sensor should be calibrated by a reputable standards laboratory using instruments with low published measurement uncertainty values. To perform the comparison, both sensors are used to measure the output power of a synthesizer with a high quality attenuator, such as the 41KC-6, on the output. The attenuator improves the source match of the synthesizer by lowering the mismatch ripples, thereby lowering the uncertainty in the comparison.

Test Procedure

1. Set up the equipment as follows (refer to Figure 12-1 for an illustration):

a. Connect the reference power sensor to the reference power meter using the appropriate cables.

b. Connect the USB cable between the personal computer with the PowerXpert application installed and the MA24108A, MA24118A, or MA24126A power sensor under test.

c. Launch the PowerXpert application.

d. Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in their respective manuals.

e. Reset or Preset all of the instruments.

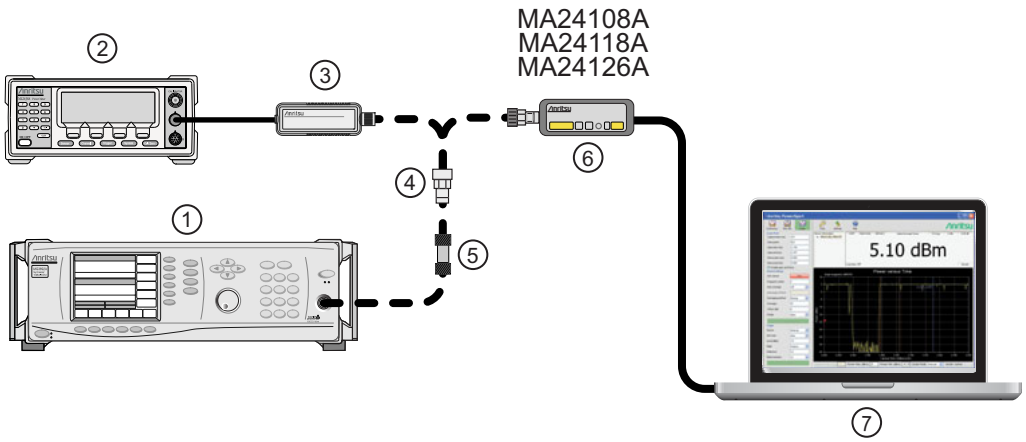
f. Configure the reference meter and sensor to measure a CW signal.

g. Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.

h. Perform a low level Zero of the MA24108A, MA24118A, or MA24126A power sensor by disconnecting it from the synthesizer, clicking the **Zero** button on the PowerXpert application, and waiting for the Zeroing message to close.

i. Connect the attenuator to the output of the synthesizer with the appropriate adapter (if required) to the output of the attenuator.

j. Set the synthesizer to +6 dBm and 50 MHz.



Index	Description
1	Synthesizer
2	Reference Power Meter
3	Reference Power Sensor
4	K to N Adapter (if required)
5	Attenuator

Figure 12-1. Cal Factor Test Set Up (1 of 2)

6	MA24108A, MA24118A or MA24126A Power Sensor
7	PC with Anritsu PowerXpert Application

Figure 12-1. Cal Factor Test Set Up (2 of 2)

2. Connect the reference sensor to the synthesizer with the appropriate adapter (if required) and attenuator in-line (see Figure 12-1).
3. Apply the Cal factor to the reference sensor per the manufacturer's instruction.
4. Record the power indicated by the reference meter in Table 12-3.
5. Disconnect the reference sensor from the synthesizer output and connect the MA24108A, MA24118A, or MA24126A power sensor with the appropriate adapter (if required) and attenuator in-line (see Figure 12-1).
6. Apply the Cal factor to the MA24108A, MA24118A, or MA24126A by entering the frequency of the measurement in GHz.
7. In the General Settings, set Averages to 4.
8. Record the power indicated by the MA24108A, MA24118A, or MA24126A in Table 12-3.
9. Set the synthesizer frequency to the next frequency in Table 12-3.
10. Repeat Step 2 through Step 9 until all of the frequencies in Table 12-3 have been measured.
11. For each row in Table 12-3, calculate the absolute value of the difference between the recorded Reference power measurement and the recorded MA24108A, MA24118A, or MA24126A measurement, and record the result in Table 12-3.
12. For each frequency, compare the power difference to the maximum allowed difference specified in Table 12-3. If the difference is higher than the maximum allowed difference, contact Anritsu customer service.

Table 12-3. Test Measurement Results (1 of 2)

Frequency (GHz)	A Reference Power Measurement (dBm)	B MA241xxA Measurement (dBm)	|A-B| Absolute Value of Difference in Power Measurements (dB)	MA24108A and MA24118A Maximum Allowed Difference (dB)	MA24126A Maximum Allowed Difference (dB)
0.01				0.51	0.55
0.05				0.29	0.31
0.1				0.29	0.31
0.3				0.27	0.29
0.5				0.27	0.29
1.0				0.27	0.29
2.0				0.27	0.29
3.0				0.30	0.33
4.0				0.30	0.33
5.0				0.30	0.33
6.0				0.30	0.33
7.0				0.32	0.35
8.0				0.32	0.35
9.0				0.32	0.37
10.0				0.32	0.37

Table 12-3. Test Measurement Results (2 of 2)

Frequency (GHz)	A Reference Power Measurement (dBm)	B MA241xxA Measurement (dBm)	|A-B| Absolute Value of Difference in Power Measurements (dB)	MA24108A and MA24118A Maximum Allowed Difference (dB)	MA24126A Maximum Allowed Difference (dB)
11.0				0.32	0.37
12.0				0.32	0.37
13.0				0.34	0.38
14.0				0.34	0.38
15.0				0.34	0.38
16.0				0.34	0.41
17.0				0.34	0.41
18.0				0.34	0.41
19.0				-	0.62
20.0				-	0.62
21.0				-	0.62
22.0				-	0.62
23.0				-	0.62
24.0				-	0.62
25.0				-	0.62
26.0				-	0.62

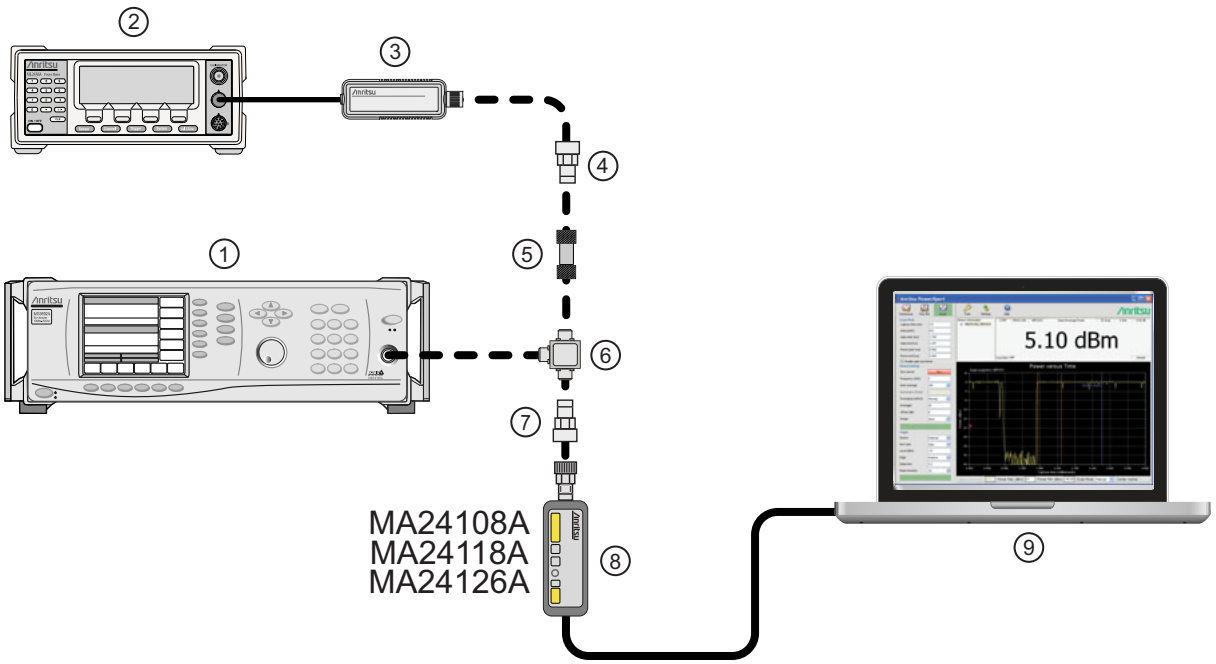
12-6 Linearity Test

The linearity correction of the MA24108A, MA24118A, or MA24126A is compared to a thermal power sensor, which has very good inherent linearity over a power range of about –20 to +10 dBm. For this reason, the MA24108A, MA24118A, or MA24126A is compared to the thermal sensor in two *ranges*, keeping the power levels to the thermal sensor in the range of –17 dBm to +5 dBm, while the power to the MA24108A, MA24118A, or MA24126A varies from about –26 dBm to about +14 dBm.

Test Procedure

1. Set up the equipment as follows (refer to Figure 12-2 for an illustration):

- **a.** Connect the reference power sensor to the reference power meter using the appropriate cables.
- **b.** Connect the USB cable between the personal computer with the PowerXpert application installed and the MA24108A, MA24118A, or MA24126A power sensor under test.
- **c.** Launch the PowerXpert application.
- **d.** Turn the power on to all of the instruments and allow them to warm up for the amount of time specified in the instrument's respective manuals.
- **e.** Reset or Preset all of the instruments.
- **f.** Configure the reference meter and sensor to measure a CW signal.
- **g.** Perform a sensor Zero and a 1 mW reference calibration on the reference sensor and meter per the manufacturer's instructions.
- **h.** Perform a low level Zero of the MA24108A, MA24118A, or MA24126A by disconnecting the it from the synthesizer, clicking the **Zero** button on the PowerXpert application, and waiting for the Zeroing message to close.
- **i.** Connect the power splitter to the output of the synthesizer, and connect the 10 dB attenuator to the reference arm of the splitter output.
- **j.** Connect an N(f) to K adapter (if required) to each power sensor.
- **k.** Connect the reference sensor and adapter to the 10 dB attenuator.
- **l.** Connect the MA24108A, MA24118A, or MA24126A and adapter (if required) to the other splitter output.
- **m.** Set the synthesizer to 50 MHz and +20 dBm.
- **n.** Increase averaging by entering "16" in the PowerXpert application, and then click **Apply above settings**.



Index	Description
1	Synthesizer
2	Reference Power Meter
3	Reference Power Sensor
4	K to N Adapter (if required)
5	Attenuator
6	Power Splitter
7	K to N Adapter (if required)
8	MA24108A, MA24118A or MA24126A Power Sensor
9	PC with Anritsu PowerXpert Application

Figure 12-2. Linearity Test Setup 1

2. Apply the Cal factor to the reference sensor per the manufacturer's procedure.

3. Apply the Cal factor by entering the frequency of the measurement in GHz.

4. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24108A, MA24118A, or MA24126A.

5. Turn On the synthesizer's RF output.

6. Record data for the first 20 dB range as follows:

a. Record the power reading by the reference meter in Table 12-4 on page 12-10.

b. Record the power reading by the MA24108A, MA24118A, or MA24126A in Table 12-4.

c. Set the synthesizer power to +15 dBm.

d. Record the reference meter and the MA24108A, MA24118A, or MA24126A power sensor readings in Table 12-4.

e. Repeat the measurement for synthesizer output levels of +10, +5, and 0 dBm.

Note	The MA24108A, MA24118A, or MA24126A power measured at 0 dBm will be used in Step 7e, below.

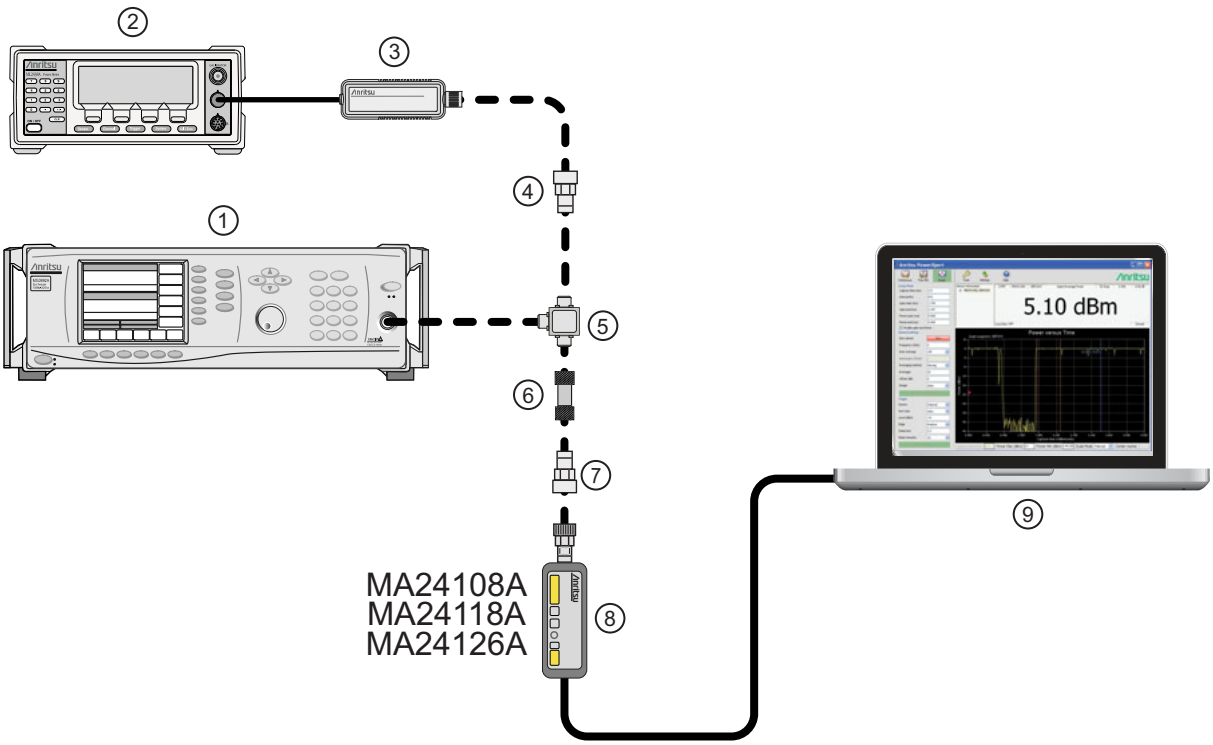
7. Set up the test for the second 20 dB range as follows:

a. Remove the 10 dB attenuator from in between the reference sensor and splitter and connect the reference sensor (with adapter, if required) directly to the splitter.

b. Remove the MA24108A, MA24118A, or MA24126A from the splitter and connect the 10 dB attenuator between the splitter and the power sensor (see Figure 12-3).

c. Turn Off the synthesizer's RF output and perform a low-level Zero of both the Reference sensor and the MA24108A, MA24118A, or MA24126A.

d. Turn On the synthesizer's RF output.



Index	Description
1	Synthesizer
2	Reference Power Meter
3	Reference Power Sensor
4	K to N Adapter (if required)
5	Power Splitter
6	Attenuator
7	K to N Adapter (if required)
8	MA24108A, MA24118A or MA24126A Power Sensor
9	PC with Anritsu PowerXpert Application

Figure 12-3. Linearity Test Setup 2

e. Set the synthesizer output level to +10 dBm, then adjust its power level until the sensor/meter under test reads as close as possible to the 0 dBm value obtained above in Step 6e.

8. Record data for the next 20 dB range

a. Read and record the power indicated by the reference meter in Table 12-4.

b. Lower the output power level of the synthesizer to +5 dBm.

c. Record the reference meter and the MA24108A, MA24118A, or MA24126A power sensor readings in Table 12-4.

d. Repeat the measurement for synthesizer output levels of 0, –5, and –10 dBm.

Table 12-4. Measurement Results (50 MHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	-5	0		0		10		
10	-10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

9. Perform the calculations and operation check as follows:

a. Subtract the Reference Power Measurement of row 5 from the Reference Power Measurement of row 6. Record this value in the Correction column of rows 1 through 5.

Note	The Correction column of rows 1 through 5 should all have the same value. The Correction column of rows 6 through 10 have values of 0.

b. Add the Reference Power Measurement and Correction values of row 1 and record the result in the Corrected Reference Power Measurement column of row 1.

c. Repeat Step 9b for rows 2 through 10.

d. Subtract the MA24108A, MA24118A, or MA24126A Measurement of row 1 from the Corrected Reference Power Measurement of row 1 and record the result in the Difference Calculation column of row 1.

e. Repeat Step 9d for rows 2 through 10.

f. Find the largest (most positive) value in the Difference Calculation column and record this value next to the word Max in row 11.

g. Find the smallest (least positive or most negative) value in the Difference Calculation column and record this value next to the word Min in row 12.

h. Subtract the Min value from Step 9g from the Max value from Step 9f and record the result next to the word Delta in row 13.

i. The Delta result should be less than 0.3 dB. If it is larger, contact Anritsu customer service.

10. Repeat the entire measurement and calculations with synthesizer frequency settings of 2 GHz, 4 GHz, 6 GHz, 10 GHz, 12 GHz, 14 GHz, 16 GHz, 18 GHz, 20 GHz, 22 GHz, 24 GHz, and 26 GHz.

Table 12-5. Measurement Results (2 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	C–D Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-6. Measurement Results (4 GHz) (1 of 2)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		

Table 12-6. Measurement Results (4 GHz) (2 of 2)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-7. Measurement Results (6 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-8. Measurement Results (8 GHz) (1 of 2)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		

Table 12-8. Measurement Results (8 GHz) (2 of 2)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-9. Measurement Results (10 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-10. Measurement Results (12 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-11. Measurement Results (14 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-12. Measurement Results (16 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-13. Measurement Results (18 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-14. Measurement Results (20 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-15. Measurement Results (22 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-16. Measurement Results (24 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Table 12-17. Measurement Results (26 GHz)

Row #	Synthesizer Power Level Setting (dBm)	Attenuation in Reference Arm (dB)	A Reference Power Measurement (dBm)	B = (A6–A5) Correction (dB)	C = (A+B) Corrected Reference Power Measurement (dB)	Attenuation in Test Arm (dB)	D MA241xxA Measurement (dBm)	E = (C–D) Difference Calculation (dB)
1	+20	10				0		
2	+15	10				0		
3	+10	10				0		
4	+5	10				0		
5	0	10				0		
6	adjust per Step 7e	0		0		10		
7	+5	0		0		10		
8	0	0		0		10		
9	–5	0		0		10		
10	–10	0		0		10		
11							Max:	
12							Min:	
13							Delta (E11 – E12):	

Chapter 13 — Remote Operation

13-1 Introduction

This chapter describes the supported remote programming commands for each power sensor model. Programming commands are classified into three main groups with the following functions and modes:

- Section 13-3 “General Purpose Commands”
- Section 13-4 “Mode Commands”
  - “Continuous Average Mode (CA Mode)”
  - “Slot Mode”
  - “Scope Mode”
- Section 13-5 “Trigger Commands”
  - “Trigger Source”
  - “Trigger Level”
  - “Trigger Edge”
  - “Trigger Delay”
  - “Trigger Noise Immunity”
  - “Trigger Arming”

The sensor starts up in the HOLD mode (the START command is sent to put the sensor in run mode).

13-2 Programming the Sensor

Send and Receive Format

Every communication with the power sensor must be suffixed with the line feed (*LF*) character (ASCII 0x0A). Every response from the sensor is also suffixed with the same character (except when using Microsoft HyperTerminal, which uses a carriage return as the identifier). The sensor rejects any command without the line feed character with a `NO TERM` response. All commands and responses mentioned in this document are assumed to be suffixed with a new line character. The following considerations must also be observed:

- Command arguments presented in this document are enclosed in angle brackets: <argument>. The angle brackets are not included as part of the actual argument.
- Floating point numbers are truncated to integers by commands that only use integers as input. For example, if the number of averages is set as 2000.937, the firmware truncates the number to 2000.
- For the MA24108A, MA24118A, and MA24126A sensors, use only two digits after the decimal in floating point arguments (except FREQ, which uses four digits after the decimal, and gate parameters, which allow three digits after decimal).

HyperTerminal

Only the MA24105A, MA24108A, MA24118A, and MA24126A sensors are compatible with Windows HyperTerminal. When programming the sensor with HyperTerminal, the carriage return is used as the termination character instead of a new line. The HyperTerminal port should be configured with a baud rate of 9600 bits per second. To properly format the commands and responses for HyperTerminal, the following check boxes should be checked in Properties | Settings | ASCII Setup:

- Send line ends with line feeds
- Echo typed characters locally
- Append line feeds to incoming line ends

Time Resolution

The maximum time resolution of the sensor is 10 µs, hence all of the time arguments have a 10 µs resolution. This does not apply to the MA24105A sensor.

Sampling Rate

The MA24108A, MA24118A, and MA24126A sensors have two sampling rates. For "Continuous Mode" and Internal "Trigger Source", the sensor has a sampling time of 6.8288 µs or a sampling frequency of 146.438 kHz. External "Trigger Source" has a sampling time of 7.3347 µs, or a sampling frequency of 136.338 kHz.

Error Responses

Any unrecognized command is rejected by the sensor with a `BAD CMD` message. A valid command coupled with an invalid command is rejected by the sensor with an `ERR` message. A command failure is also indicated by the sensor with an `ERR` message.

Default Sensor Settings

The sensor settings in Table 13-1 apply to the MA24105A.

Table 13-1. General Default Sensor Settings, MA24105A

Setting	Command	Default Value
Mode of Operation	`FORWARD` `REVERSE`	Continuous Forward Mode Continuous Reverse Mode
Measurement Frequency	`FREQ`	0.35 GHz
Number of Averages	`AVGCNT`	1
Range	`SETRNG`	Auto range (0)

The sensor settings in Table 13-2, Table 13-3 and Table 13-4 apply to the MA24108A, MA24118A, MA24126A.

Table 13-2. General Default Sensor Settings, MA24108A, MA24118A, MA24126A

Setting	Command	Default Value
Mode of Operation	`CHMOD`	"Continuous Average Mode (CA Mode)" (0)
Measurement Frequency	`FREQ`	0.010 GHz
Averaging Algorithm	`AVGTYP`	Moving (0)
Number of Averages	`AVGCNT`	1
Auto Averaging	`AUTOAVG`	Off (0)
Auto Averaging Source	`AUTOAVGSRC`	1
Auto Average Resolution	`AUTOAVGRES`	0.01 (2)
Range	`SETRNG`	Auto range (0)

Table 13-3. Continuous Average Mode Default Sensor Settings, MA24108A, MA24118A, MA24126A

Setting	Command	Default Value
Aperture Time	`CHAPERT`	20 ms
Duty Cycle Correction	`CWDUTY`	100 %

Table 13-3. Continuous Average Mode Default Sensor Settings, MA24108A, MA24118A, MA24126A

Setting	Command	Default Value
Relative Mode	CWREL	Off (0)

Table 13-4. Slot Mode Default Sensor Settings, MA24108A, MA24118A, MA24126A

Setting	Command	Default Value
Number of Slots	TSLTPARAMS	8
Slot Width	TSLTPARAMS	10 ms
Start Exclusion	TSLTPARAMS	0.02 ms
End Exclusion	TSLTPARAMS	0.02 ms

Table 13-5. Scope Mode Default Sensor Settings, MA24108A, MA24118A, MA24126A

Setting	Command	Default Value
Capture Time	SCOPEPARAMS	20 ms
Number of Points	SCOPEPARAMS	200
Gate	GENABLE	Disabled (0)
Gate Start	GATEPARAMS	0 ms
Gate End	GATEPARAMS	20 ms
Fence Start	GATEPARAMS	0 ms
Fence End	GATEPARAMS	0 ms

Table 13-6. Trigger Default Sensor Settings, MA24108A, MA24118A, MA24126A

Setting	Command	Default Value
Trigger Source	TRGSRC	Continuous (0)
Trigger Arm Type	TRGARMTYP	Standby (3)
Trigger Level	TRGLVL	0 dBm
Trigger Edge	TRGEDG	Positive (0)
Trigger Delay	TRGDLY	0 ms
Trigger Noise Parameter	TRGNOISE	1

13-3 General Purpose Commands

General purpose commands are used to set/read the general settings of the sensor. These commands are not mode or trigger dependent. All of the commands for the MA24104A, MA24105A and MA24106A sensors are confined to this section. Most of the commands in this section are compatible with the MA24108A, MA24118A, and MA24126A sensors.

START

Description: Sets the sensor to measurement mode from the idle mode.

Syntax: START *+LF*

Return Value: OK

Remarks: This command should be the first command sent. The sensor sends OK to each START command. If the sensor is in the HOLD mode, then it will change the mode to the RUN mode. If it is not in HOLD mode, it will not change the sensor's mode.

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

STOP

Description: Sets the power sensor to idle mode.

Syntax: STOP *+LF*

Return Value: OK

Remarks: This command should be sent before exiting the application.

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

IDN?

Description: Gets the identification information from the sensor.

Syntax: IDN? *+LF*

Return Value: ANRITSU, Model #, Serial #, Module Serial #, firmware version

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

CALDATE

Description: Returns the last calibration date of the sensor.

Syntax: *CALDATE +LF*

Return Value: Calibration date of the sensor in mm/dd/yyyy format

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

PWR?

Description: Gets the current power reading (in dBm) from the sensor output buffer in the continuous average mode.

Syntax: `PWR? +LF`

Return Value: Power value in dBm or ERR

Remarks: If an error condition exists, "e" precedes the output and the sensor's LED turns yellow. Use the STATUS? command for details about the error.

This command returns an error ("ERR") if used in slot or scope modes.

This command returns "busy" if used in repeat average mode with immediate trigger (if the sensor has not completed the averaging cycle).

In simple repeat average mode, it will echo the latest value from the buffer. The buffer will update only when the averaging cycle is complete.

In moving average mode, it will return the current power reading in the buffer.

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

PWRALL

Description: Gets all the measurements shown in Return Value

Syntax: `PWRALL +LF`

Return Value: Forward average power, Crest Factor, Burst Average Manual, Peak Envelop Power, Reverse Average Power, Reflection Coefficient, Return Loss, Standing Wave Ratio

Remarks: Returns comma separated values in the sequence shown in the return value above.

Compatible Sensor: MA24105A

FREQ

Description: Sets the current calibration factor frequency value for the power sensor.

Syntax: `FREQ <freq> +LF`

Return Value: OK or ERR

Remarks: The frequency <freq> value is in GHz and must be within the operating limits of the power sensor.

For the MA24104A and MA24106A, resolution is 0.000001 GHz (1 Hz)

For the MA24105A, "num" is the cal factor frequency value in GHz and must be between 0.35 GHz to 4.0 GHz.

For the MA24105A, MA24108A, MA24118A, and MA24126A, resolution is 0.0001 GHz (100 kHz).

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

FREQ?

Description: Gets the current calibration factor frequency value of the power sensor.

Syntax: `FREQ? +LF`

Return Value: Current calibration factor frequency in GHz.

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

ZER0

Description: Zeros the power sensor.

Syntax: ZER0 *+LF*

Return Value: 0K if zero is successful or ERR if zero fails.

Remarks: Zeroing the sensor is essential for taking accurate readings as it cancels any offsets in the preamplifiers and channel noise. The sensor should be zeroed without any input RF power. In case of zero failure, the STATUS? command can be used to retrieve more detail about the error.

For the MA24105A, zeroing the sensor takes 75 seconds to complete and will take at least this long to get a response from the sensor.

For all other models, zeroing the sensor takes 20 seconds to complete and will take at least this long to get a response from the sensor.

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

TMP?

Description: Gets the current temperature reading from the sensor.
On the MA24105A, gets the current temperature reading from both forward and reverse temperature sensors. The return value for this reading is a comma separated value (for example; 25,28).

Syntax: TMP? *+LF*

Return Value: Current temperature reading of the sensor in degrees Celsius
On the MA24105A, current temperature reading of Forward and Reverse in degrees Celsius. The return value for this reading is a comma separated value (for example; return value “25,28” means the forward temperature is 25 degrees Celsius and the reverse temperature is 28 degrees Celsius).

Compatible Sensor: MA24104A, MA24105A, MA24106A, MA24108A, MA24118A, MA24126A

STATUS?

Description: Gets the current error status codes from the sensor.

Syntax: STATUS? *+LF*

Return Value: Error status codes.

Remarks: For the MA24104A and MA24106A, the error status codes are as follows:
Status.b0: ZERO_TEMP_ERROR (Temperature changed more than allowable limit after zeroing sensor)
Status.b1: Not Used
Status.b2: ADC_CH2_OR (Temperature over range)
Status.b3: ADC_CH3_OR (Detector A over ranged)
Status.b4: ZERO_ERROR_DET_A
Status.b5: ZERO_ERROR_DET_B
Status.b6: TEMP_ERROR (Temperature beyond operating range)
Status.b7: Not Used

For the MA24105A, the error status codes are 16-bit numbers, each bit of which represents an error:
Bit 0: Temperature change of more than 10 C after zeroing
Bit 1: Operating temperature over range < 0 C or > 60 C
Bit 2: Forward low zeroing error
Bit 3: Forward high zeroing error
Bit 4: Reverse zeroing error
Bit 5: PEP zeroing error
Bit 6: CCDF zeroing error
Bit 7: Forward high over range
Bit 8: Reverse over range
Bit 9: PEP over range
Bit 10: Flash Data Error

For the MA24108A, MA24118A, and MA24126A, the error status codes are 16-bit numbers, each bit of which represents an error:
Bit 0: Temperature change of more than 10 °C after zeroing
Bit 1: Operating temperature over range < 0 °C or > 60 °C
Bit 2: Detector A zeroing error
Bit 3: Detector B zeroing error
Bit 4: Detector A over range

Compatible Sensor: MA24104A, MA24105A, MMA24106A, MA24108A, MA24118A, MA24126A

HAT

Description: Sets the high aperture time mode.

Syntax: HAT *+LF*

Return Value: OK or ERR

Remarks: This command will put the sensor in high aperture time mode. In this mode, the A to D converter integration time is about 160 milliseconds.

Compatible Sensor: MA24104A, MA24106A

LAT

Description: Sets the low aperture time mode.

Syntax: `HAT +LF`

Return Value: `OK` or `ERR`

Remarks: This command will put the sensor in low aperture time mode. In this mode, the A to D converter integration time is about 10 milliseconds. This mode is the default mode for the sensor when powered up.

Compatible Sensor: MA24104A, MA24106A

ASDON

Description: Turns on auto shutdown mode

Syntax: `ASDON +LF`

Return Value: `OK` or `ERR`

Remarks: This command applies when RS232 connectivity is used with battery power. This is the default mode at power up. In this mode, the sensor will automatically go into sleep mode to conserve battery power if the RS-232 serial port cable is disconnected from the host. The sensor will wake up when an active host is reconnected and must be zeroed before taking measurements.

Compatible Sensor: MA24104A

ASDOFF

Description: Turns off auto shutdown mode

Syntax: `ASDOFF +LF`

Return Value: `OK` or `ERR`

Remarks: This command applies when RS232 connectivity is used with battery power. In this mode, the sensor will not go into sleep mode if the RS-232 serial port cable is disconnected from the host.

Compatible Sensor: MA24104A

RST

Description: Resets the sensor to factory default settings.

Syntax: `RST +LF`

Return Value: `OK`

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

CHOLD

Description: Sets the current power sensor state.

Syntax: `CHOLD <state> +LF`

Return Value: `OK` or `ERR`

Remarks: <state> is an integer value that represents a specific mode:

0 – Run
1 – Hold

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

CHOLD?

Description: Gets the current power sensor state.

Syntax: `CHOLD? +LF`

Return Value: An integer value.

Remarks: This command queries the sensor state. Returned value can be:
0 – Run
1 – Hold

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

SETRNG

Description: Sets the detector range of the sensor.

Syntax: `SETRNG <det_range> +LF`

Return Value: `OK` or `ERR`

Remarks: <det_range> is an integer with the following values:
0 – Auto Range
1 – Channel A (covers the power range from +20 dBm to –7 dBm)
2 – Channel B (covers the power range from –7 dBm to –40 dBm)

For MA24105A, <det_range> is an integer with the following values:
0 – Auto Range
1 – Low Power (covers the power range from +3 dBm to +40 dBm)
2 – High Power (covers the power range from +40 dBm to +51.76 dBm)

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

SETRNG?

Description: Gets the detector range setting of the sensor.

Syntax: `SETRNG? +LF`

Return Value: An integer with the following values:
0 – Auto Range
1 – Channel A (covers the power range from +20 dBm to –7 dBm)
2 – Channel B (covers the power range from –7 dBm to –40 dBm)

For MA24105A, an integer with the following values:
0 – Auto Range
1 – Low Power (covers the power range from +3 dBm to +40 dBm)
2 – High Power (covers the power range from +40 dBm to +51.76 dBm)

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

SAVE

Description: Saves a user defined setup to the power sensor.

Syntax: `SAVE <setup> +LF`

Return Value: `OK` or `ERR`

Remarks: <setup> is an integer from 1 to 10 that is translated into a storage location. Therefore, there are 10 presets the user can store.ERR is returned if <setup> is out of range.

Compatible Sensor: MA24108A, MA24118A, MA24126A

DELETE

Description: Deletes all user defined setups in the power sensor.

Syntax: `DELETE +LF`

Return Value: `OK` or `ERR`

Compatible Sensor: MA24108A, MA24118A, MA24126A

RECALL

Description: Recalls one of the 10 user defined setups from the power sensor.

Syntax: `RECALL <setup> +LF`

Return Value: `OK` or `ERR`

Remarks: <setup> is an integer from 1 to 10 that is translated into a storage location. Hence, there are 10 presets the user can recall from. ERR is returned if <setup> is out of range.

Compatible Sensor: MA24108A, MA24118A, MA24126A

RDBUF

Description: Reads the buffer in Scope and Time Slot modes.

Syntax: `RDBUF +LF`

Return Value: Current power readings from the sensor buffer separated by commas.

Remarks: This command is used to read out the entire array of points for the recent measurement run from the sensor output buffer, which contains reading from Scope and Time Slot modes. The power readings are in mW. The power values are separated by a comma (,) and the buffer is prefixed and suffixed by $ (the dollar sign) to mark the beginning and end of the buffer. Each power reading has six digits after the decimal point (0.000001 mW).

In case of an error, "e" precedes the output. Use the STATUS? command for details about the error. If the gate (discussed in "Scope Mode") is enabled, then the gate average power is also suffixed at the end of the output. For example, for four points with gate enabled, the RDBUF response is:
`$,<P1>,<P2>,<P3>,<P4>,$,<GP>`

Time Slot mode with 4 slots will send out the buffer as:
`$,-3.233454,0.124355,0.233443, 0.223456,$`

Compatible Sensor: MA24108A, MA24118A, MA24126A

FULLBUF

Description: Sets the full sensor buffer enable.

Syntax: `FULLBUF <n> +LF`

Return Value: `OK` or `ERR`

Remarks: <n> is an integer value that represents a specific mode:
0 – Off
1 – On

This command has effect only if the sensor is internally or externally triggered. If full buffer is turned ON, the sensor will return the full buffer in triggered mode (default operation). If full buffer is turned OFF, the sensor only returns the gated average power value enclosed in the $ (dollar sign). For example: `$,3.54546,$`

If the sensor is in Slot mode or the gates are turned off, the sensor returns:
`$,Sensor triggered, output is disabled,$`

In case of an error, "e" followed by the error code precedes the output. For example:
`e25$,2.565677,$`
or
`e25$,Sensor triggered, output is disabled,$`

Compatible Sensor: MA24108A, MA24118A, MA24126A

CWDUTY

Description: Sets the duty cycle correction.

Syntax: `CWDUTY <duty_correction> +LF`

Return Value: `OK` or `ERR`

Remarks: <duty_correction> is the duty cycle correction percentage from 0.01 to 100.

For the MA24105A, this correction applies only to Burst Average Manual measurement.

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

CWDUTY?

Description: Gets the duty cycle correction value.

Syntax: `CWDUTY? +LF`

Return Value: Duty cycle correction percentage.

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

CWREL

Description: Sets the CA relative power mode status ON or OFF.

Syntax: `CWREL <relative> +LF`

Return Value: `OK` or `ERR`

Remarks: In the relative power mode, the power is calculated relative to the current power value when the command is sent. <relative> is an integer with the following values:
0 – Relative mode OFF
1 – Relative mode ON

Compatible Sensor: MA24108A, MA24118A, MA24126A

CWREL?

Description: Gets the CA relative mode status ON or OFF.

Syntax: `CWREL? +LF`

Return Value: 0 or 1

Remarks: In the relative power mode, the power is calculated relative to the current power value when the command is sent. <relative> is an integer with the following values:
0 – Relative mode OFF
1 – Relative mode ON

Compatible Sensor: MA24108A, MA24118A, MA24126A

AVGTYP

Description: Sets the power sensor's averaging type of Moving or Repeat.

Syntax: `AVTYP <average_type> +LF`

Return Value: `OK` or `ERR`

Remarks: <average_type> is an integer with the following values:
0 – Moving
1 – Repeat mode ON

Compatible Sensor: MA24108A, MA24118A, MA24126A

AVGTYP?

Description: Gets the current power sensor's averaging type of Moving or Repeat.

Syntax: `AVTYP? +LF`

Return Value: An integer with the following values:
0 – Moving
1 – Repeat mode ON

Compatible Sensor: MA24108A, MA24118A, MA24126A

AVGCNT

Description: Sets the number of averages in the Continuous, Average, Time Slot, or Scope modes.

Syntax: `AVGCNT <num_avgs> +LF`

Return Value: `OK` or `ERR`

Remarks: Time Slot and Scope modes are applicable only to MA24108A, MA24118A, MA24126A.

Average count is the number of measurements used to calculate the average power stored in the output buffer of the sensor. The maximum number of averages is 40,000 for up to 200 points. The averaging number is limited by the formula:

Max Averaging Number = 8231936 / points
For MA24105A, Max Averaging Number = 512 / points

In the Auto Average mode, this command is ineffective as the number is set automatically depending on the power level and resolution required. (There is no Auto Average for MA24105A).

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

AVGCNT?

Description: Gets the number of averages in the Continuous, Average, Time Slot, or Scope modes.

Syntax: AVGCNT? *+LF*

Return Value: For MA24108A, MA24118A, MA24126A, an integer value between 1 and 40,000. For MA24105A, an integer value between 1 and 512.

Remarks: The command can also be used in the auto-average mode.

Time Slot and Scope modes applicable only to MA24108A, MA24118A, MA24126A.

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

AUTOAVG

Description: Sets the Auto Average mode to ON, OFF or AUTO ONCE.

Syntax: AUTOAVG <average_mode> *+LF*

Return Value: OK or ERR

Remarks: The Auto Average mode depends on three factors, Auto Average Resolution, Capture Time, and the Auto Average Source, which are set by their own commands as explained later. <average_mode> is an integer with the following values:
0 – OFF
1 – ON
2 – AUTO ONCE (ON for one iteration only and is turned OFF automatically once the averaging number is set)

Compatible Sensor: MA24108A, MA24118A, MA24126A

AUTOAVG?

Description: Gets the Auto Average mode of ON, OFF or AUTO ONCE.

Syntax: AUTOAVG? *+LF*

Return Value: An integer with the following values:
0 – OFF
1 – ON
2 – AUTO ONCE (ON for one iteration only and automatically OFF once the averaging number is set)

Compatible Sensor: MA24108A, MA24118A, MA24126A

AUTOAVGSRC

Description: Sets the Auto Average Source value for Time Slot and Scope modes.

Syntax: AUTOAVGSRC <average_source> *+LF*

Return Value: OK or ERR

Remarks: The <average_source> number is calculated from the average power of only one Time Slot or Scope Point. If the <average_source> value is set out of bounds, auto averaging is ineffective. For auto averaging to be effective, the auto average source must be set less than the number of points in scope mode, or set less than the number of slots in slot mode. AUTOAVGSRC is disabled in CA mode.

Compatible Sensor: MA24108A, MA24118A, MA24126A

AUTOAVGSRC?

Description: Gets the Auto Average Source value for Time Slot or Scope mode.

Syntax: AUTOAVGSRC? *+LF*

Return Value: An integer with the auto averaging source value.

Compatible Sensor: MA24108A, MA24118A, MA24126A

AUTOAVGRES

Description: Sets the Auto Average resolution (digits after decimal point).

Syntax: AUTOAVGRES <average_resolution> *+LF*

Return Value: OK or ERR

Remarks: The <average_resolution> number is set according to the desired resolution. Higher resolution results in more averaging and slower throughput of data.
<average_resolution> must range from 0 to 3.

Compatible Sensor: MA24108A, MA24118A, MA24126A

AUTOAVGRES?

Description: Gets the Auto Average resolution.

Syntax: AUTOAVGRES? *+LF*

Return Value: Integer from 0 to 3

Remarks: The Auto Averaging number is set according to the desired resolution. Higher resolution results in more averaging and slower throughput of data.

Compatible Sensor: MA24108A, MA24118A, MA24126A

AVGRST

Description: Resets the averaging count and clears the averaging buffers.

Syntax: AVGRST *+LF*

Return Value: OK

Compatible Sensor: MA24105A, MA24108A, MA24118A, MA24126A

FORWARD

Description: Sets the forward measurement mode.

Syntax: FORWARD <*num*> *+LF*

Details: num = 1 to 6

Return Value: OK or ERR

Remarks: 1 – Forward Average
2 – Crest Factor
3 – Burst Average Manual
4 – Peak Envelope Power
5 – Burst Average Auto
6 – CCDF

Compatible Sensor: MA24105A

FORWARD?

Description: Gets the forward measurement mode.

Syntax: `FORWARD? +LF`

Return Value: `num = 1 to 6`

Remarks: 1 – Forward Average
2 – Crest Factor
3 – Burst Average Manual
4 – Peak Envelope Power
5 – Burst Average Auto
6 – CCDF

Compatible Sensor: MA24105A

REVERSE

Description: Sets the reverse measurement mode

Syntax: `REVERSE <num> +LF`

Details: `num = 1 to 4`

Remarks: 1 – Reverse Average
2 – Reflection Coefficient
3 – Return Loss
4 – Standing Wave Ratio (VSWR)

Compatible Sensor: MA24105A

REVERSE?

Description: Gets the reverse measurement mode

Syntax: `REVERSE? +LF`

Return Value: `num = 1 to 4`

Remarks: 1 – Reverse Average
2 – Reflection Coefficient
3 – Return Loss
4 – Standing Wave Ratio (VSWR)

Compatible Sensor: MA24105A

VIDEOBW

Description: Sets the video BW

Syntax: `VIDEOBW <num> +LF`

Details: `num = 0 to 2`

Return Value: `OK or ERR`

Remarks: 0 – Full
1 – 4 kHz
2 – 200 kHz

Compatible Sensor: MA24105A

VIDEOBW?

Description: Gets the video BW

Syntax: `VIDEOBW? +LF`

Return Value: `num = 0 to 2`

Remarks: 0 – Full
1 – 4 kHz
2 – 200 kHz

Compatible Sensor: MA24105A

MODTYPE

Description: Sets the modulation type

Syntax: `MODTYPE <num> +LF`

Details: `num = 0 to 5`

Return Value: `OK or ERR`

Remarks: 0 – NONE
1 – GSM_GPRS_EDGE
2 – WCDMA_HSPA_SINGLE_CARRIER
3 – WCDMA_HSPA_MULTI_CARRIER
4 – ISDB_T
5 – CDMA_IS95_2000_EVDO

Compatible Sensor: MA24105A

MODTYPE?

Description: Gets the modulation type

Syntax: `MODTYPE? +LF`

Return Value: `num = 0 to 5`

Remarks: 0 – NONE
1 – GSM_GPRS_EDGE
2 – WCDMA_HSPA_SINGLE_CARRIER
3 – WCDMA_HSPA_MULTI_CARRIER
4 – ISDB_T
5 – CDMA_IS95_2000_EVDO

Compatible Sensor: MA24105A

CCDFTHRESH

Description: Sets the threshold for CCDF

Syntax: `CCDFTHRESH <num> +LF`

Return Value: `OK or ERR`

Remarks: <num> is a value in dBm. The range of CCDF threshold values that can be entered is 3 dBm to 54.77 dBm.

Compatible Sensor: MA24105A

CCDFTHRESH?

Description: Gets the threshold for CCDF

Syntax: `CCDFTHRESH <num> +LF`

Return Value: `Last threshold value`

Compatible Sensor: MA24105A

13-4 Mode Commands

The power sensor supports the following three modes of operation:

- "Continuous Average Mode (CA Mode)"
- "Slot Mode"
- "Scope Mode"

The power sensor starts up in the "Continuous Average Mode (CA Mode)" mode after the "START" command is issued and continuously reads power. The "CHMOD" command is issued to change the sensor's mode of operation. Mode-specific commands can be issued when the sensor is in any other mode, but will only affect the sensor operation if the sensor is in the mode for which the command is issued. When the sensor mode is changed, the parameters/settings get updated automatically.

CHMOD

Description: Sets the current power sensor mode and loads related settings.

Syntax: `CHMOD <mode> +LF`

Return Value: `OK` or `ERR`

Remarks: <mode> is an integer value as follows:
0 – Continuous Average Mode
1 – Time Slot Mode
2 – Scope Mode
3 – Idle Mode

Compatible Sensor: MA24108A, MA24118A, MA24126A

CHMOD?

Description: Gets the current power sensor mode.

Syntax: `CHMOD? +LF`

Return Value: Integer value as follows:
0 – Continuous Average Mode
1 – Time Slot Mode
2 – Scope Mode
3 – Idle Mode

Compatible Sensor: MA24108A, MA24118A, MA24126A

Continuous Average Mode (CA Mode)

CA mode is the default mode of operation. In CA mode, the sensor is continuously triggered and collects data at all times. Capture time is the only parameter associated with CA mode. The sensor calculates one average power averaged over the entire capture time. For example, for 20 ms of capture time, the sensor collects 2860 samples (with an approximate142 kHz sampling rate). The CA power is the average of the 2860 samples for each 20 ms time frame. The power can be read using the "PWR?" command. The related CA mode commands are listed below.

CHAPERT

Description: Sets the effective capture time (aperture time) for average power measurements.

Syntax: CHAPERT <capture_time> +*LF*

Return Value: OK or ERR

Remarks: <capture_time> must range from a maximum of 300 ms to a minimum of 0.01 ms and has a resolution of 0.01 ms.

Compatible Sensor: MA24108A, MA24118A, MA24126A

CHAPERT?

Description: Gets the effective capture time (aperture time) for average power measurements.

Syntax: CHAPERT? +*LF*

Return Value: Channel aperture time for CA mode in ms.

Compatible Sensor: MA24108A, MA24118A, MA24126A

Slot Mode

Slot mode operation is generally useful when doing measurement on slotted TDMA signals like GSM. The slot mode breaks up the measurement in time slots and calculates the average power reading for each individual slot. The slot mode measurement can be continuously triggered, but more often it is internally or externally triggered. Triggering is discussed in Section 13-5. To set up the sensor in slot mode operation, the following four parameters must be set:

- **Number of Slots:** The number of slots is the number of time slots in the measurement. There is one power reading for each slot, the power reading being the averaged power of all the samples falling within that slot. The maximum number of slots is 128.
- **Slot Width:** Slot width is the width of each slot in milliseconds. The minimum slot width is 0.01 ms (approximately one sample) and the maximum slot width is 100 ms.
- **Start Exclusion:** Start exclusion is the time in milliseconds that is excluded from the beginning of each slot for power calculation.
- **End Exclusion:** End exclusion is the time in milliseconds that is excluded at the end of each slot for power calculation.

Note	Slot Width x Number of Slots = Total Capture Time. Total Capture Time cannot exceed 300 ms. The exclusions should not eclipse the entire slot width. Start Exclusion + End Exclusion must be less than the slot width.

The "TSLTPARAMS" command sends all of the above parameters at once. The "TSLTPARAMS?" command receives all of the above parameters at once.

TSLTPARAMS

Description: Sets all of the slot mode parameters.

Syntax: `TSLTPARAMS <num1,num2,num3,num4> +LF`

Return Value: `OK` or `ERR`

Remarks: The input parameters are comma separated values and must be sent in the correct order as follows:
num1: Number of Slots
num2: Slot Width
num3: Start Exclusion Time
num4: End Exclusion Time
An asterisk `"*"` can be used instead of a value if the parameter is not to be changed. For example, `TSLTPARAMS 8,20,*,1` updates the Number of Slots to 8, the Slot Width to 20 ms, the Exclusion End Time to 1 ms. The Exclusion Start Time remains unchanged. Returns `ERR` if the input values are out of range.

Compatible Sensor: MA24108A, MA24118A, MA24126A

TSLTPARAMS?

Description: Sets all of the slot mode parameters.

Syntax: `TSLTPARAMS? +LF`

Return Value: Comma separated string with the following four values:
num1: Number of Slots
num2: Slot Width
num3: Start Exclusion Time
num4: End Exclusion Time

Compatible Sensor: MA24108A, MA24118A, MA24126A

Scope Mode

In scope mode, the sensor acts similarly to an oscilloscope in that it can be used to measure power as a function of time. Two parameters are needed to define the Scope mode operation: the collection period and the number of data points. In Scope mode, the sensor first waits for a trigger. Once a trigger is received, the sensor collects data at its sample rate of approximately 142 ksps for the duration of the capture time. This typically results in a number of samples that exceeds the number of data points requested, and individual samples are then averaged together to reduce the data set to the requested number of data points.

Gate and Fence

A gate and a fence can be set up to compute the average power of all the points within the gate. The fence is used to mask the unwanted portion of the gate, but a fence remains entirely within the gate. Any points falling within the fence are rejected for the average gate power calculation. Setting the fence start and fence end to zero disables the fence. The gate can be enabled or disabled as desired by using the gate enable "GENABLE" command. If the gate is enabled, the average power, maximum power, minimum power and crest within the gate can be queried by using the gate power "GATEVALUES?" query. All values are based on data points and NOT on the individual raw sample packets in the gate.

Capture Time

The capture time is the total time in milliseconds captured by the sensor in a single run. The maximum capture time is 300 ms. The capture time can not be made equal to or less than the negative trigger delay. In case of a conflict between trigger delay and capture time, an error is returned when setting scope parameters.

Number of Data Points

The number of data points can never be set less than the total number of samples. For a given capture time, the lower the number of data points, the more samples that are averaged per point, thus the lower the trace noise. The sensor supports a maximum of 1024 data points if there are enough samples. For example, 20 ms of capture time results in 2860 samples (~142 KHz sampling frequency). If there are 10 data points, then each data point contains the averaged data of 286 samples. The entire data point array is read out by the "RDBUF" command as explained in the previous section. Hence, "RDBUF" reads out 10 data point values separated by a comma (,).

Gate Start

Gate start marks the start of the gate in milliseconds with respect to the trigger (start of capture). The Gate start value can not be negative and it can not exceed the capture time.

Gate End

Gate end marks the end of the gate in milliseconds with respect to the trigger. The Gate end value can not be less than the Gate start value and it can not exceed the capture time.

Fence Start

Fence start marks the beginning of the fence in milliseconds with respect to the trigger. The fence start must always be inside the gate (unless the fence is disabled by setting both the fence start and the fence end to zero).

Fence End

Fence end marks the end of the fence in milliseconds with respect to the trigger. The fence end must always be between fence start and the Gate end (unless the fence is disabled by setting both the fence start and the fence end to zero). If the fence start value and the fence end value are the same, then the fence is ineffective.

The following commands set the Scope mode parameters:

SCOPEPARAMS

Description: Sets the scope mode parameters.

Syntax: SCOPEPARAMS <num1,num2> +LF

Return Value: OK or ERR

Remarks: The input parameters are comma separated values and must be sent in the correct order as follows:
num1: Data Capture Time (maximum 300 ms)
num2: Number of Points
An asterisk "*" can be used instead of a value if the parameter is not to be changed. For example, SCOPEPARAMS *,4 updates the number of points to 4, while the data capture time is unchanged. A space is treated as a zero. Returns ERR if the input values are out of range.

Compatible Sensor: MA24108A, MA24118A, MA24126A

SCOPEPARAMS?

Description: Gets the scope mode parameters.

Syntax: SCOPEPARAMS? +LF

Return Value: Comma separated string with the following two values:
num1: Data Capture Time
num2: Number of Points

Compatible Sensor: MA24108A, MA24118A, MA24126A

GATEPARAMS

This command sets the gate parameters. The parameters are comma separated in the order: gate start, gate end, fence start, fence end. An asterisk (*) can be used instead of a value if the user does not want to change that parameter.

Description: Sets the gate parameters.

Syntax: GATEPARAMS <num1,num2,num3,num4> +LF

Return Value: OK or ERR

Remarks: The input parameters are comma separated values (in ms) and must be sent in the correct order as follows:
num1: Gate Start
num2: Gate End
num3: Fence Start
num4: Fence End
For example, GATEPARAMS 0,20,5,15 updates the Gate Start to 0 ms, the Gate End to 20 ms, the Fence Start to 5 ms, and the Fence End to 15 ms. An asterisk "*" can be used instead of a value if the parameter is not to be changed. Returns ERR if the input values are out of range.

Compatible Sensor: MA24108A, MA24118A, MA24126A

GATEPARAMS?

Description: Gets the gate parameters.

Syntax: `GATEPARAMS? +LF`

Return Value: Comma separated string with the following four values:
num1: Gate Start
num2: Gate End
num3: Fence Start
num4: Fence End

Compatible Sensor: MA24108A, MA24118A, MA24126A

GENABLE

Description: Enables or disables the gate.

Syntax: `GENABLE <gate> +LF`

Return Value: `OK` or `ERR`

Remarks: <gate> is an integer with the following values:
0 – Disable
1 – Enable
Returns `ERR` if <gate> is out of range or if the gate is improperly set up.

Compatible Sensor: MA24108A, MA24118A, MA24126A

GENABLE?

Description: Gets the gate enable/disable status.

Syntax: `GENABLE?`

Return Value: 0 – Disable
1 – Enabled

Compatible Sensor: MA24108A, MA24118A, MA24126A

GATEVALUES?

Description: Gets the gate average power, peak power, minimum power, and crest for the most recent scope measurement run (with gate enabled).

Syntax: `GATEVALUES?`

Return Value: Comma separated string with the following four values:
num1: Average Power (in dBm)
num2: Peak Power (in dBm)
num3: Minimum Power (in dBm)
num4: Crest Power (in dB)

Remarks: All return values are based on data points and NOT on the individual raw sample packets in the gate. In case of an error, `"e"` precedes the output. For example: `"e2.453,3.456,5.234,2.435"`

Compatible Sensor: MA24108A, MA24118A, MA24126A

13-5 Trigger Commands

Trigger is an event that initiates a measurement. When the sensor is armed, it waits for a trigger. Once the trigger occurs, the sensor starts data collection, calculation, and averaging to complete a measurement.

Trigger commands must be sent after general setup of the power sensor as the general settings impact the trigger setup. Before arming the sensor for a trigger, the sensor must be set up with the following trigger related parameters:

- "Trigger Source"
- "Trigger Level"
- "Trigger Edge"
- "Trigger Delay"
- "Trigger Noise Immunity"
- "Trigger Arming"

"Trigger Arming" commands should be sent to the sensor last and just before triggering because any other type of command aborts the armed state and places the sensor in standby mode. For Time Slot and Scope modes, the sensor's default arming state is standby.

Trigger Source

The power sensor supports four different types of triggers (trigger sources):

Continuous Trigger

When the trigger source is set to continuous, the sensor is continuously collecting data. It does not look for a trigger and is triggered all the time. Because the sensor is always collecting data, it does not depend on any other trigger related parameters.

Internal Trigger

If internal trigger source is set, the sensor triggers based on the signal power, edge and noise immunity factor set in the sensor. These parameters can be set with their respective commands as discussed later.

External Trigger

When the sensor is setup with external trigger, it is triggered by the TTL/CMOS signal on the external trigger pin. In this trigger source, sensor can be set up to trigger at a particular edge of the TTL/CMOS signal. External trigger does not depend on any other trigger related parameter.

Bus Trigger

Bus trigger is a manual trigger that allows the user to manually control the trigger by sending the `"TRGIMM"` command. The bus trigger is command based and is not set up like the other trigger sources, and it does not depend on any trigger-related parameters.

All of the trigger sources (except Bus Trigger) work in conjunction with the trigger arm types discussed later. A trigger setup is incomplete if the sensor is not armed. The trigger source can be set and read with the following commands:

TRGSRC

Description: Sets the trigger source.

Syntax: `TRGSRC <trigger_source> +LF`

Return Value: OK or ERR

Remarks: <trigger_source> is an integer with the following values:
0 – Continuous
1 – Internal
2 – External

Compatible Sensor: MA24108A, MA24118A, MA24126A

TRGSRC?

Description: Gets the trigger source.

Syntax: `TRGSRC? +LF`

Return Value: An integer with the following values:
0 – Continuous
1 – Internal
2 – External

Compatible Sensor: MA24108A, MA24118A, MA24126A

TRGIMM

Description: Triggers the sensor immediately and starts taking new readings.

Syntax: `TRGIMM +LF`

Return Value: Power reading in dBm or BUSY

Remarks: Once the sensor receives this command, the sensor starts collecting data for the capture time defined by the sensor's mode. Once all data collection, calculation, and averaging is complete, the sensor automatically outputs the power reading and returns to the previous state (before TRGIMM was received). The sensor is programmed to repeat averaging if triggered manually, irrespective of the type of average type set in the sensor.

Upon completion, if the sensor is in continuous mode, it outputs one power reading in dBm (same as the "PWR?" command) and if the sensor is in scope/slot mode, it sends the entire buffer out (like RDBUF command). If the power is requested (by sending PWR? or RDBUF commands) before the sensor is done with averaging, the sensor returns BUSY. There is no need to arm the trigger when using bus trigger.

Compatible Sensor: MA24108A, MA24118A, MA24126A

Trigger Level

Trigger level is the power value that triggers the sensor when it is crossed. This parameter has no effect in continuous, external or bus trigger setups.

TRGLVL

Description: Sets the trigger level in dBm.

Syntax: `TRGLVL <trigger_level> +LF`

Return Value: OK or ERR

Remarks: <trigger_level> must be from –20 dBm to +20 dBm in 0.01 dB steps.

Compatible Sensor: MA24108A, MA24118A, MA24126A

TRGLVL?

Description: Gets the trigger level in dBm.

Syntax: `TRGLVL? +LF`

Return Value: Trigger level in dBm

Compatible Sensor: MA24108A, MA24118A, MA24126A

Trigger Edge

Sets the trigger edge for internal and external trigger. Trigger edge can be set to positive or negative.

For internal trigger, the sensor triggers only when the signal crosses the trigger level from high to low when set to negative; the sensor triggers only when the signal crosses the trigger level from low to high when set to positive.

For external trigger, the sensor triggers when the TTL signal on the external trigger pin falls from high to low when set to negative; the sensor triggers when the TTL signal on the external trigger pin rises from low to high when set to positive.

TRGEDG

Description: Sets the trigger edge.

Syntax: `TRGEDG <trigger_edge> +LF`

Return Value: OK or ERR

Remarks: <trigger_edge> is an integer with the following values:
0 – Positive
1 – Negative

Compatible Sensor: MA24108A, MA24118A, MA24126A

TRGEDG?

Description: Gets the trigger edge setting.

Syntax: `TRGEDG? +LF`

Return Value: An integer with the following values:
0 – Positive
1 – Negative

Compatible Sensor: MA24108A, MA24118A, MA24126A

Trigger Delay

Trigger delay is the time in milliseconds between the trigger event and when the sensor starts taking readings. The trigger delay can be either positive or negative. The trigger delay can be set from –5 ms to 10,000 ms with a resolution of 0.01 ms.

If the delay is negative, the sensor starts taking the readings before the trigger occurs and the total capture time includes the negative delay time. For example, for a capture time of 20 ms and a delay of –1 ms, the length of the capture would be from –1 ms to 19 ms, given the trigger occurs at time, t = 0. The negative delay can not be greater than or equal to the capture time. If the capture time conflicts with the trigger delay, the trigger delay command returns an error.

If the delay is positive, the sensor waits for the set delay time after a trigger before it starts taking readings. The sensor is unresponsive during the wait period and can not be aborted. The capture time is unaffected by a positive trigger delay.

TRGDLY

Description: Sets the trigger delay in msec

Syntax: `TRGDLY <trigger_delay> +LF`

Return Value: OK or ERR

Remarks: <trigger_delay> is the trigger delay value in msec and must range from –5 ms to 10,000 ms with a resolution of 0.01 ms.

Compatible Sensor: MA24108A, MA24118A, MA24126A

TRGDLY?

Description: Gets the trigger delay in msec

Syntax: `TRGDLY? +LF`

Return Value: Trigger delay in ms

Compatible Sensor: MA24108A, MA24118A, MA24126A

Trigger Noise Immunity

When internally triggering on very noisy signals, the sensor can trigger at an undesired point or edge. To provide immunity against such situations, the sensor can be set to wait for N number of samples to cross the trigger level before it triggers.

The value of N is the trigger noise immunity factor and is set by the "TRGNOISE" command, where N is a value from 1 to 10. Higher values of N result in increased noise immunity, but also increase the trigger latency. It is advised to use a negative trigger delay when using noise immunity. The negative delay required to reduce the trigger latency is the product of N and the sample duration of the power sensor, which is approximately 7 µs.

TRGNOISE

Description: Sets the trigger noise immunity factor.

Syntax: `TRGNOISE <noise> +LF`

Return Value: `OK` or `ERR`

Remarks: <noise> is an integer from 1 to 10. Higher values of <noise> result in increased noise immunity, but also increase the trigger latency.

Compatible Sensor: MA24108A, MA24118A, MA24126A

TRGNOISE?

Description: Gets the trigger noise immunity factor.

Syntax: `TRGNOISE? +LF`

Return Value: An integer from 1 to 10

Compatible Sensor: MA24108A, MA24118A, MA24126A

Trigger Arming

The trigger parameters are effective only if the sensor is *armed*. Armed is the state when the sensor is waiting for a trigger. By default, the sensor is in *Standby* mode and must be armed before it can be triggered. "Trigger Arming" should be the last command sent to the sensor before triggering as any other type of command aborts the armed state and places the sensor in standby mode.

When the sensor is armed, it waits for a trigger indefinitely. Once the trigger occurs, the sensor starts data collection, calculation, and averaging to complete a measurement. The measurement result is sent in dBm (in CA mode) or in mW (in Time Slot and Scope modes). After setting up the sensor, the sensor can be armed as follows:

Auto Armed

In this arming state, the sensor is automatically rearmed after one trigger has occurred and the measurement has been output. Auto Armed is generally used in Time Slot and Scope modes to continuously monitor the signal.

Single Armed

In this arming state, the sensor is armed only once before the trigger. Once triggered, the sensor performs the measurement, outputs the result, and returns to the standby mode. The sensor makes N number of measurement runs and outputs the average power on completion of averaging the N measurements. N is the averaging number set in the sensor. However, in moving average mode, the intermediate moving average power is also sent after each measurement run, the last one being the most accurate as it has the effect of all of the N measurements. The sensor triggers only once and all of the measurements follow.

Multiarmed

In this arming state, the sensor is automatically rearmed for N number of times after each of N trigger events, and then the sensor outputs one measurement result at the completion of all triggered events. N is the number of averages set in the sensor prior to arming (set with the `"AVGCNT"` command). If there are N averages set in the sensor, the sensor will look for N triggers, make N measurements and send out one averaged power for all of the N triggered measurements. However, in moving average mode, the intermediate, moving average power is also sent after each triggered measurement, the last one being the most accurate as it has the average of all of the N measurements. For multiarmed triggering, at least N triggers must occur for the sensor to complete the entire measurement. The sensor is rearmed until it has received all N number of triggers. Once the measurements are complete, the sensor is set to the Standby mode.

Standby

In standby mode, the sensor is not waiting for a trigger and is UNARMED.

Trigger arming is effective only in the Internal and External trigger modes. Arming has no effect when the sensor is continuously triggered.

TRGARMTYP

Description: Sets the trigger arming state.

Syntax: `TRGARMTYP <arm_type> +LF`

Return Value: `OK` followed by measurement results, or `ERR`

Remarks: <arm_type> is an integer with the following values:
0 – "Auto Armed"
1 – "Single Armed"
2 – "Multiarmed"
3 – "Standby"

Compatible Sensor: MA24108A, MA24118A, MA24126A

TRGARMTYP?

Description: Gets the trigger arming state.

Syntax: TRGARMTYP? *+LF*

Return Value: An integer with the following values:
0 – "Auto Armed"
1 – "Single Armed"
2 – "Multiarmed"
3 – "Standby"

Compatible Sensor: MA24108A, MA24118A, MA24126A

Appendix A — Sample Visual Basic Code

A-1 Demo Application

The CD contains a demo application that allows you to interface with the power sensor using the remote programming protocol. The sample code is written in Microsoft® Visual Basic® 6.0 and is given at the end of this appendix. The complete project, DemoApp.vbp, is available on the CD that shipped with the sensor. The Demo Application's main form is shown below:

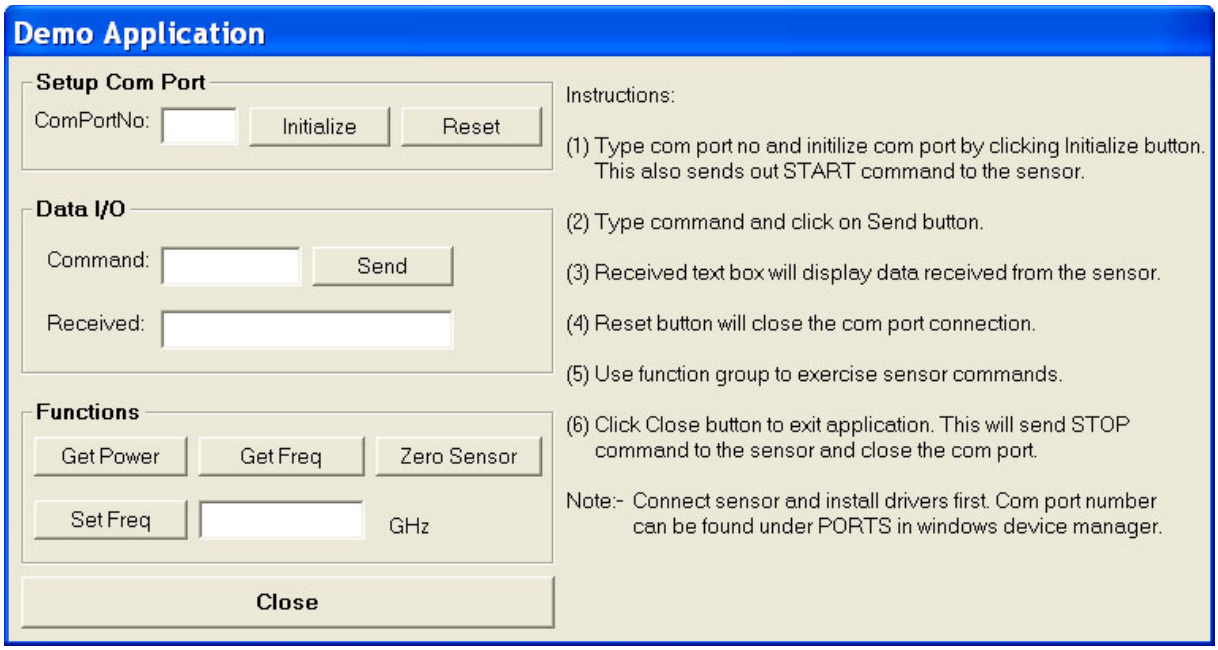

Demo Application
Setup Com Port
ComPortNo:
Initialize
Reset
Data I/O
Command:
Send
Received:
Functions
Get Power
Get Freq
Zero Sensor
Set Freq
GHz
Close
Instructions:
(1) Type com port no and initilize com port by clicking Initialize button. This also sends out START command to the sensor.
(2) Type command and click on Send button.
(3) Received text box will display data received from the sensor.
(4) Reset button will close the com port connection.
(5) Use function group to exercise sensor commands.
(6) Click Close button to exit application. This will send STOP command to the sensor and close the com port.
Note:- Connect sensor and install drivers first. Com port number can be found under PORTS in windows device manager.

Figure A-1. Demo Application

Anritsu recommends that you use the source code and project available on the CD that shipped with the sensor to minimize typing errors. You may need to add Microsoft® Comm Control 6.0 manually, which can be added from Visual Basic® 6.0 IDE by navigating to: Project | Components.

A-2 Using the Demo Application

To launch the Demo Application:

1. Go to the PowerXpert CD home page and click on Open Sample Program Folder. Windows Explorer will open. Double click on **DemoApp.exe**. The application screen shown in Figure A-1 will appear.
2. Connect the power sensor to the PC using the USB cable. The sensor shows up as a Serial port device on the PC. You can find its COM port number using the device manager in the Windows® control panel.
3. Type the COM port number in the ComPortNo: text box and click **Initialize**.

   Once the COM port is initialized, you can type commands in the Command text box, and then click the **Send** button. Refer to Chapter 13, "Remote Operation" for a list of available commands. Any responses from the sensor will be displayed in the Received text box. You can use the Functions group buttons to exercise the sensor for power readings, frequency readings and settings, and for zeroing sensor.

Note	The Demo Application uses Microsoft Comm Control, which limits COM Port number usage to less than 16 (COM3 to COM16).

```
**************************************************************************
// This sample program shows how to control an Anritsu USB power sensor using
//Microsoft Visual basic 6.0

Option Explicit
Public gstrInputBuffer As String

'Event handler for InitializeComPort button
Private Sub btnInitializeComPort_Click()
    Call SetCommPort(Val(Trim(txtCOMPORTNo.Text)))
End Sub

'Subroutine to set the com port
Public Sub SetCommPort(portNo As Integer)
    On Error GoTo errHndler
        'Setup MSComm control
        MSComm1.Settings = "115200,n,8,1"
        MSComm1.CommPort = Trim(txtCOMPORTNo.Text)
        MSComm1.PortOpen = True
        MSComm1.RThreshold = 1
        MSComm1.SThreshold = 1
        '
        'Wait for half a second before sending START command
        Delay (0.5)
        'Arm sensor to start making measurements
        txtCommand.Text = "START"
        Call btnSend_Click
        '
        Exit Sub

errHndler:
        MsgBox ("ERROR: " & Err.Description)
End Sub

'Event handler for ResetComPort button
Private Sub btnResetComPort_Click()
    'Close com port
    If MSComm1.PortOpen = True Then
       MSComm1.PortOpen = False
    End If
End Sub

'Event handler for Send button
Private Sub btnSend_Click()
  Dim strResult As String
    'Clear buffer & receive text window before sending command
    gstrInputBuffer = ""
    txtReceived.Text = ""
    'Send command and appeand Termination character, 0x0A(10)with it.
    MSComm1.Output = UCase(txtCommand.Text) & Chr(10)
    'Display received result on the Received text box
    txtReceived.Text = strResult
    '
End Sub
```

```
'
'Event handler for MSComm1 event
Private Sub MSComm1_OnComm()
    'Get data from Input buffer
    gstrInputBuffer = MSComm1.Input
    'Display received result on the Received text box
    txtReceived.Text = gstrInputBuffer
End Sub

'Event handler for GetFreq button
Private Sub btnGetFreq_Click()
    txtCommand.Text = "FREQ?"
    Call btnSend_Click
End Sub

'Event handler for GetPower button
Private Sub btnGetPower_Click()
    txtCommand.Text = "PWR?"
    Call btnSend_Click
End Sub

'Event handler for SetFreq button
Private Sub btnSetFreq_Click()
    txtCommand.Text = "FREQ " & txtFreq.Text
    Call btnSend_Click
End Sub

'Event handler for ZeroSensor button
Private Sub btnZeroSensor_Click()
    txtCommand.Text = "ZERO"
    Call btnSend_Click
    'Sensor will return OK after about 19 Seconds
End Sub

'Event handler for Close button
Private Sub btnClose_Click()
'
    'Make sure we close the com port before we exit the app
    If MSComm1.PortOpen = True Then
        'Stop sensor from making measurements
        txtCommand.Text = "STOP"
        Call btnSend_Click
        '
        'Wait for half a second after sending START command
        Delay (0.5)
        '
        MSComm1.PortOpen = False
    End If
    'Close the app
    End
End Sub
```

```
'Delay routine
Public Sub Delay(ByVal Seconds As Single)
    '
    Dim fStartTimer As Single
    Dim fFinish     As Single
    '
    fStartTimer = Timer
    '
    Do
        DoEvents
        fFinish = Timer
        If Abs(fFinish - fStartTimer) > Seconds Then
            Exit Do
        End If
    Loop
    '
End Sub
'*************************************************************************
```

Appendix B — Upgrading the Firmware

B-1 Introduction

The Anritsu PowerXpert™ application provides the necessary software to upgrade the Anritsu USB power sensor firmware. Follow the correct procedure for your sensor model as described in the following sections:

- Section B-2 “MA24104A, and MA24106A Firmware Upgrade”
- Section B-3 “MA24105A, MA24108A, MA24118A, and MA24126A Firmware Upgrade”

The current sensor firmware can be determined by expanding the Sensor Information list in PowerXpert.

B-2 MA24104A, and MA24106A Firmware Upgrade

Warning	Before launching the firmware upgrade utility, make sure that you have the firmware file available. Failure to complete the firmware installation will render the power sensor inoperable.

1. Download the latest firmware upgrade files from http://www.us.anritsu.com and save them in a recoverable location.
2. Note the COM port number to which the power sensor is connected. This can be determined by expanding the Sensor Information list in PowerXpert.
3. Launch the Update Firmware command from the **Tools** menu.
4. Click **Yes** to update the firmware:

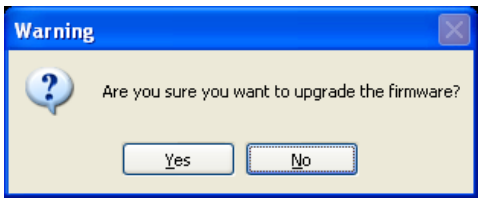


Figure B-1. Update Firmware Warning

5. Connect to the power sensor as follows:
   a. Disconnect and reconnect the USB cable from the power sensor.
   b. For the MA24104A, press and hold the power button on the sensor for three seconds to turn the sensor On.

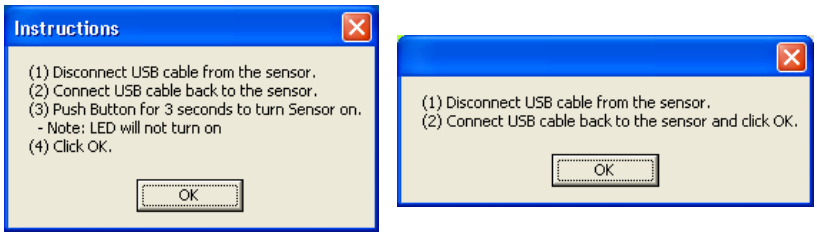

Instructions
(1) Disconnect USB cable from the sensor.
(2) Connect USB cable back to the sensor.
(3) Push Button for 3 seconds to turn Sensor on.
- Note: LED will not turn on
(4) Click OK.
OK
(1) Disconnect USB cable from the sensor.
(2) Connect USB cable back to the sensor and click OK.
OK

Figure B-2. Firmware Upgrade Dialog (MA24104A left, MA24106A, right)

6. If this is the first time that you are upgrading the sensor’s firmware, you will need to install the power sensor **upgrade** driver when the Windows Found New Hardware wizard starts **before** continuing with this procedure. If the upgrade drivers have already been installed, continue to Step 8.

7. The power sensor upgrade driver installation is similar to the power sensor driver installation detailed in Chapter 2, "Installing Power Sensor Drivers" except that, during the upgrade driver installation, Windows will ask for the path of the driver file to install mchpusb.sys (mchpusb64.sys for 64-bit systems). During this step, browse to the program installation directory:
C:\Program Files\Anritsu\PowerXpert\Drivers
Select the file and complete the upgrade driver installation.

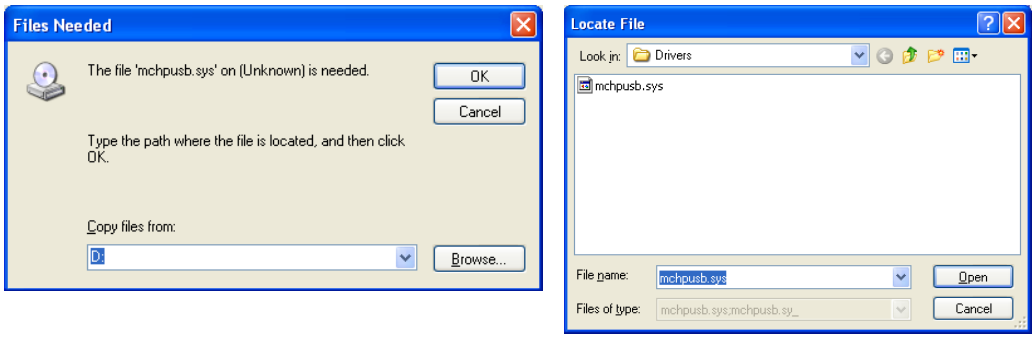


Figure B-3. Windows Locate File Dialog

8. Click **OK** to continue with the firmware upgrade procedure.

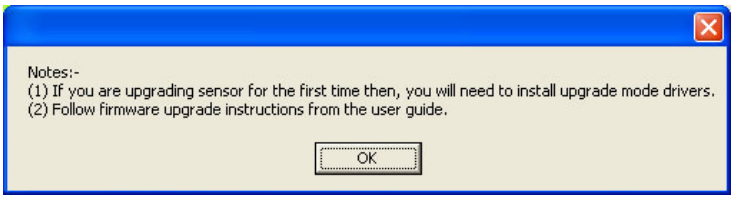

Notes:-
(1) If you are upgrading sensor for the first time then, you will need to install upgrade mode drivers.
(2) Follow firmware upgrade instructions from the user guide.
OK

Figure B-4. Firmware Upgrade Dialog

Note	If the firmware upgrade utility does not start automatically, start it from: C:\Program Files\Anritsu**PowerXpert\MA2410xxFirmwareUpgradeApp.exe**

9. Select the power sensor that you intend to upgrade from the drop-down list box.

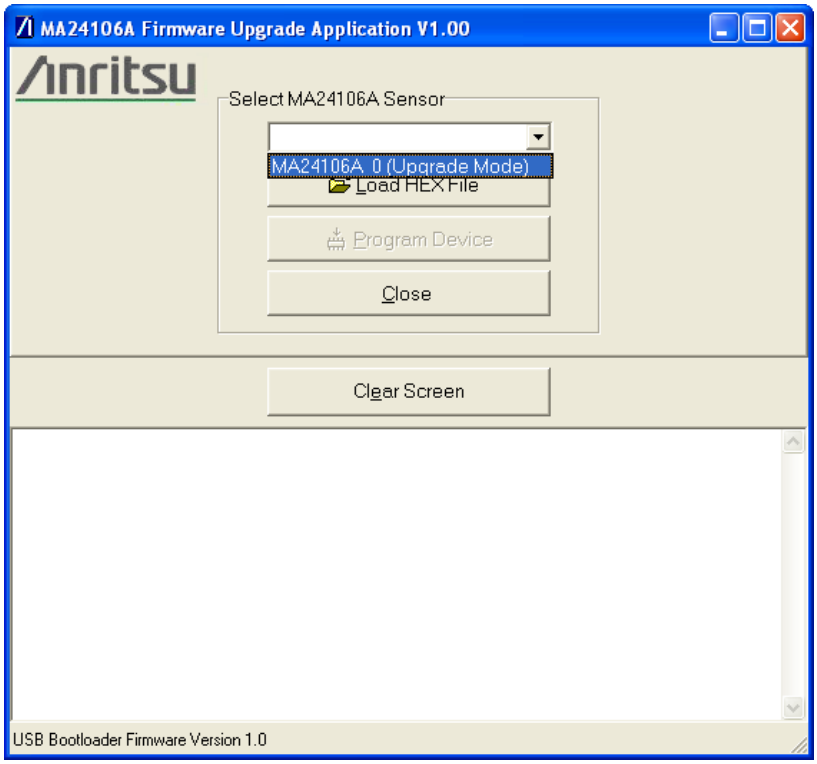


Figure B-5. Firmware Upgrade Application

10. Click **Load Hex File** and select the HEX file from the directory in which it was saved.

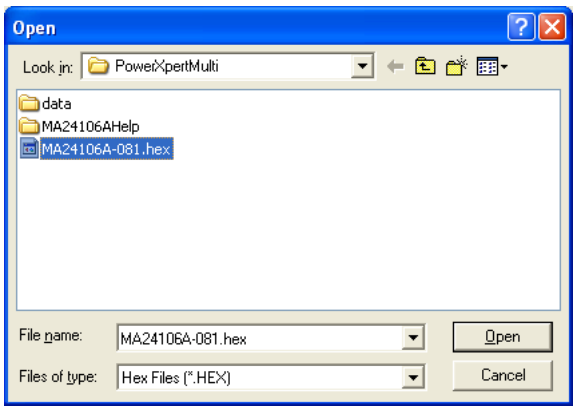


Figure B-6. Open File Dialog

Warning	Do Not disconnect the power sensor from the USB port or interrupt the firmware write sequence as this will cause an unrecoverable programming error and render the power sensor inoperable.

11. Click **Program Device**. The following messages will be displayed during the program operation:

```
MESSAGE - Programming FLASH Completed
MESSAGE - Erasing and Programming FLASH...
```

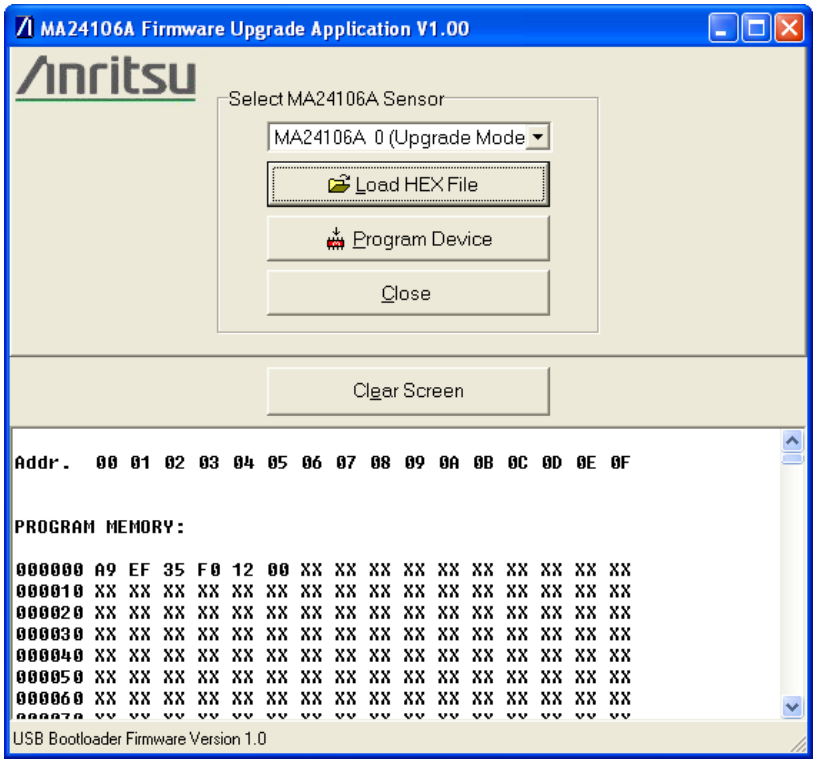

MA24106A Firmware Upgrade Application V1.00
Anritsu
Select MA24106A Sensor
MA24106A 0 (Upgrade Mode
Load HEX File
Program Device
Close
Clear Screen
Addr. 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
PROGRAM MEMORY:
000000 A9 EF 35 F0 12 00 XX XX XX XX XX XX XX XX XX XX
000010 XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX
000020 XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX
000030 XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX
000040 XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX
000050 XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX
000060 XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX
USB Bootloader Firmware Version 1.0

Figure B-7. Firmware Upgrade Application

12. Connect to the power sensor as follows:

- **a.** Disconnect, and then reconnect the USB cable from the power sensor.
- **b.** For the MA24104A, press and hold the power button on the sensor for three seconds to turn the sensor On (note that the LED will illuminate).

13. If the status light of the power sensor is green, the sensor is programmed successfully and the Anritsu PowerXpert application automatically detects the upgraded sensor.

B-3 MA24105A, MA24108A, MA24118A, and MA24126A Firmware Upgrade

1. Download the appropriate firmware upgrade file depending upon the sensor model number from: http://www.us.anritsu.com and save them in a recoverable location.

Warning	Before launching the firmware upgrade utility, make sure that you have the sensor firmware file available. Failure to complete the firmware installation will render the power sensor inoperable. Earlier versions of the MA24108A and MA24118A power sensors used an Atmel upgrade driver. This driver must first be uninstalled from the USB devices listed in Windows Device Manager **before** upgrading the firmware. See "Removing Old Upgrade Driver" on page B-7.

2. Launch PowerXpert.

3. Launch the Update Firmware command from the **Tools** menu.
When this command is sent to the sensor, the sensor goes into upgrade mode and the status LED turns yellow. The LED must turn yellow before continuing with the following steps.

4. Click **Yes** to update the firmware:

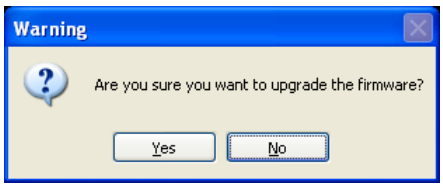


Figure B-8. Update Firmware Warning

Note	If this is the first time that you are upgrading the sensor's firmware, you need to install the "Anritsu Sensor Upgrade Driver" when the Windows Found New Hardware wizard starts *before* continuing with this procedure. If the **upgrade mode** drivers are not installed for the power sensor, install the drivers *before* clicking **OK** in the dialog box shown above. If **OK** is clicked before the drivers are installed, the COM port of the sensor will not be enumerated in the upgrade utility and the upgrade utility will need to be manually launched from the application folder after installing the drivers. The power sensor upgrade driver installation is similar to the power sensor driver installation detailed in "Installing Power Sensor Drivers" on page 2-5 except that the sensor will be identified as "Anritsu Sensor Upgrade Driver". The system should automatically find the driver and install it after a warning. **Windows 7 operating system:** the "Anritsu Sensor Upgrade Driver" is referred to as "GPS camera detect" by the OS because of a conflict in the drivers. The SAM-BA functionality remains unaffected.

5. Disconnect and reconnect the USB cable from the power sensor.

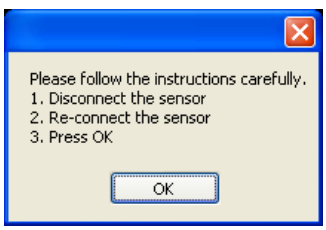


Figure B-9. Update Firmware Dialog

6. If the upgrade drivers have already been installed, continue to Step 7.

Note	If the SAM-BA firmware upgrade utility does not start automatically, start it from: C:\Program Files\Anritsu\PowerXpert**SensorUpgradeUtility.exe**

7. In the SAM-BA dialog, configure your connection and board as follows:

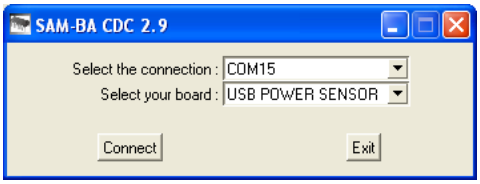


Figure B-10. SAM-BA Configuration Dialog

Note	The SAM-BA firmware upgrade utility requires that the serial ports between COM2 and COM49 be used. You can find out the COM port number by going to: Start | Settings | Control Panel | System | Hardware | Device Manager | Ports (COM & LPT). If the assigned COM port for the “Anritsu Sensor Upgrade Driver” is COM50 or greater, then the COM port number must be reassigned to less than COM50 and the SAM-BA firmware upgrade utility must be relaunched from C:\Program Files\Anritsu\PowerXpert\SensorUpgradeUtility.exe. Refer to Appendix C for additional information.

a. Select or type the connection: **COMX**, where X is the COM port number to which the upgrade mode sensor is connected. The COM port number can be checked from the Windows Device Manager. If you do not see the sensor listed in the **Device Manager | Ports**, see “Removing Old Upgrade Driver” on page B-7.

b. Select your board: **USB_POWER_SENSOR**

c. Click **Connect** to launch the SAM-BA firmware upgrade utility.

8. Click **Yes** in the External RAM init. dialog.

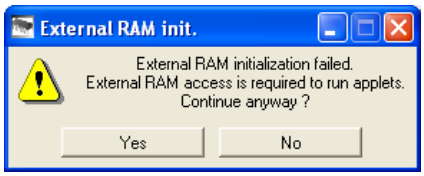


Figure B-11. External RAM init. Dialog

9. In the SAM-BA firmware upgrade utility shown in Figure B-12, do the following:

a. In the Send File Name field, browse for the latest firmware file downloaded from the Anritsu Web site (MA24108A.bin or MA24118A.bin).

b. Click **Send File** (a Sending File status message should pop up).

c. After the bin file is sent, click **No** in the Lock region(s) to lock pop-up dialog.

d. In the scripts group box, select Boot from flash (GPNVM 2), and then click **Execute**.

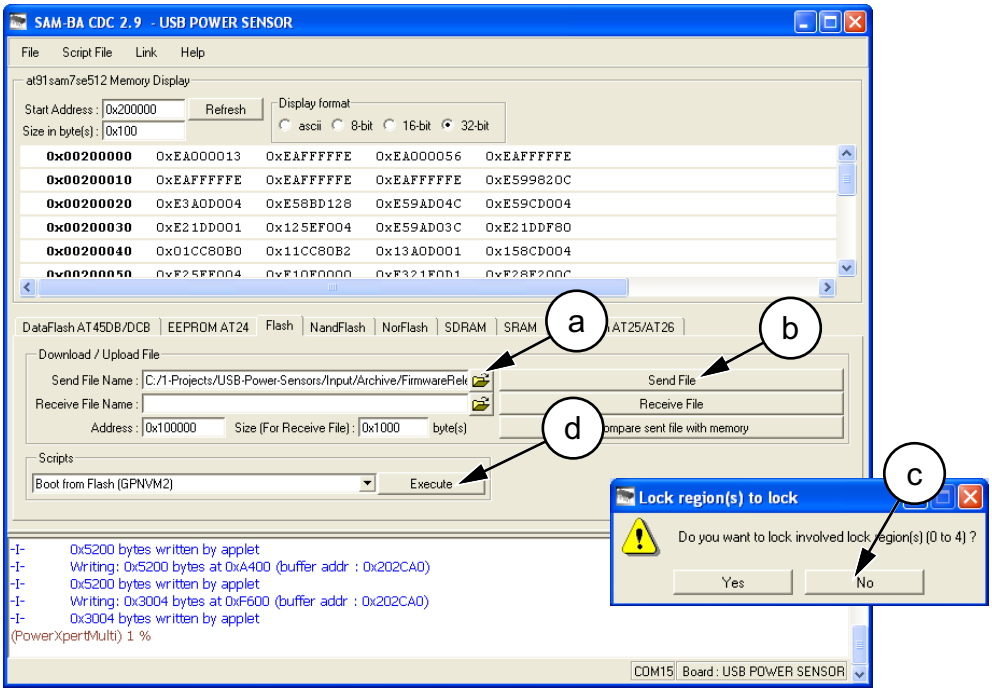


Figure B-12. SAM-BA Firmware Upgrade Utility

10. Close the SAM-BA interface and disconnect the sensor from the USB cable.

11. Reconnect the sensor. If the status light is green, the sensor is programmed successfully and the Anritsu PowerXpert application automatically detects the upgraded sensor.

Removing Old Upgrade Driver

Use this procedure if you need to remove earlier installations of an Anritsu PowerXpert sensor upgrade driver.

Once you click the upgrade button and disconnect and reconnect the sensor, the sensor should show up as Anritsu Sensor Upgrade Driver in **Device Manager | Ports**. If it does not show up in the list and does not ask for a driver, remove the old drivers.

The old driver can be seen in **Device Manager | Universal Device Controllers** listed as atm6124.sys ATMEL AT91xxxxx Test Board when you connect a sensor in upgrade mode. Right click this item and select **Uninstall** to remove this driver. Disconnect the sensor and reconnect the sensor connect again. The system should look for the driver. Complete the driver installation as mentioned in the note with Step 5 on page B-5. You should now see the sensor listed as Anritsu Sensor Upgrade Driver in **Device Manager | Ports** and be able to complete the sensor firmware upgrade.

Appendix C — USB/Serial Port Compatibility

C-1 Introduction

The SAM-BA upgrade utility requires that the serial ports between COM2 and COM49 are used. You can find out the COM port number by going to **Start | Settings | Control Panel | System | Hardware | Device Manager | Ports (COM & LPT)**. Disconnect and reconnect the power sensor's USB cable from the computer and notice the new COM port number that appears in the Ports list.

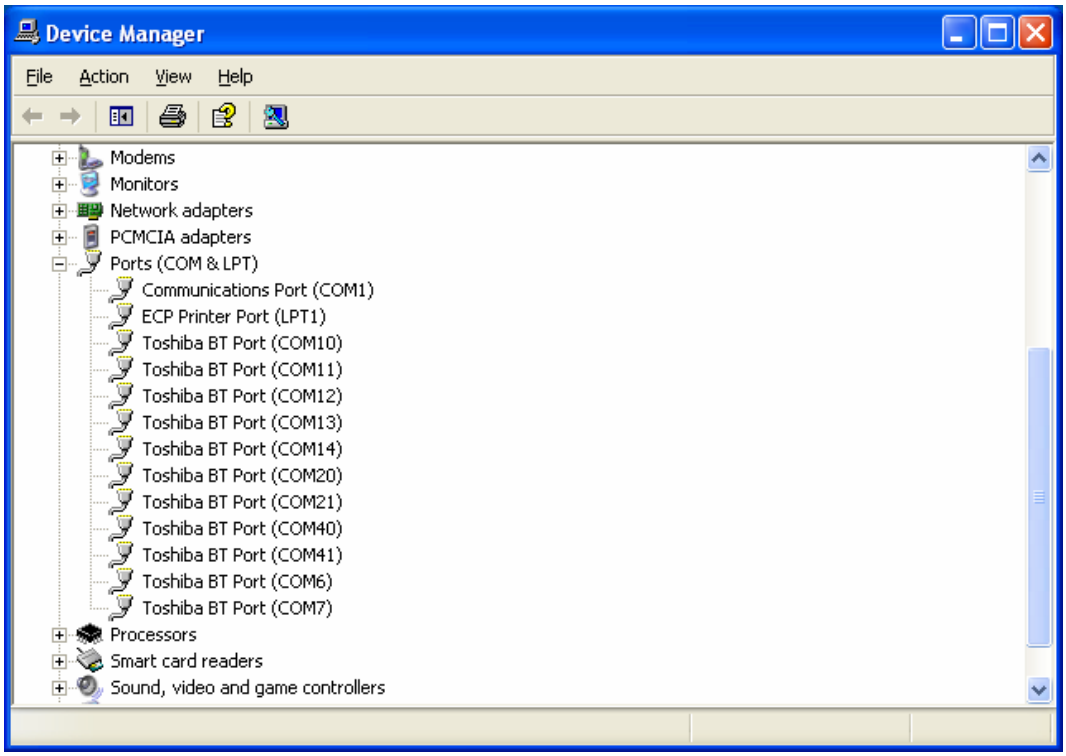


Figure C-1. Device Manager

If this number is less than 49, then the PC application will work fine. However, in some cases when the power sensor is connected, Windows may map your serial port to a port number greater than 49, such as COM51 or COM52 depending on which USB port that is being used. If you connect your power sensor and the SAM-BA upgrade utility displays No Sensor, a port number above COM49 may be assigned. To correct this problem, you will need to follow one of the three options outlined below. Whichever method you use, you should only need to perform the procedure once.

- Method 1–Download Updated Software
- Method 2–Trying a Different USB Port
- Method 3–Remapping a Serial Port

C-2 Method 1–Download Updated Software

The preferred method for resolving serial port compatibility issues is to download software updates for your product from www.us.anritsu.com.

C-3 Method 2–Trying a Different USB Port

1. Disconnect the USB end of your power sensor from your computer (or USB hub).
2. Connect the USB power sensor to a different USB port on your computer. Connecting to a USB hub tends to increase the port numbers, so connecting directly to the computer's USB port usually provides the best result.
3. Open the Device manager to see if the new port assignment is between COM2 and COM49. If it is NOT, return to step 1 and connect to a different USB port. If the port assignment is between COM2 and COM49, the problem has been resolved and no further action is required.

C-4 Method 3–Remapping a Serial Port

A serial port may be remapped to a different number, such as changing a serial port from COM19 to COM5. This may be needed if the methods above do not result in a serial port assignment between COM2 and COM49 or if you prefer to use a USB hub or a specific USB port on your computer.

1. Open the System Properties by going to **Start | Settings | Control Panel | System**, or simultaneously pressing the **Windows** and **Pause** keys.
2. Select the **Hardware** tab and click the **Device Manager** button to open the Device Manager.

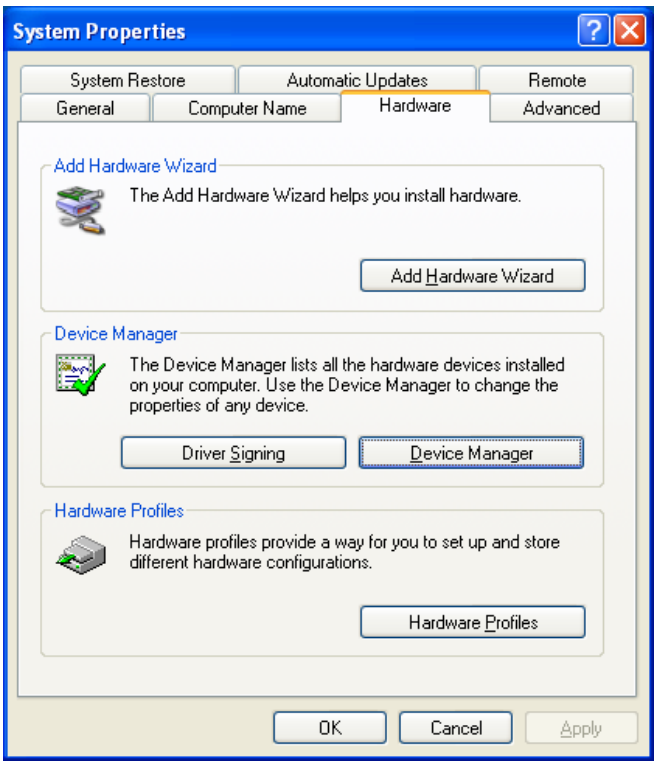


Figure C-2. System Properties

3. Click the **+** box next to Ports (COM & LPT) to expand the installed ports list.

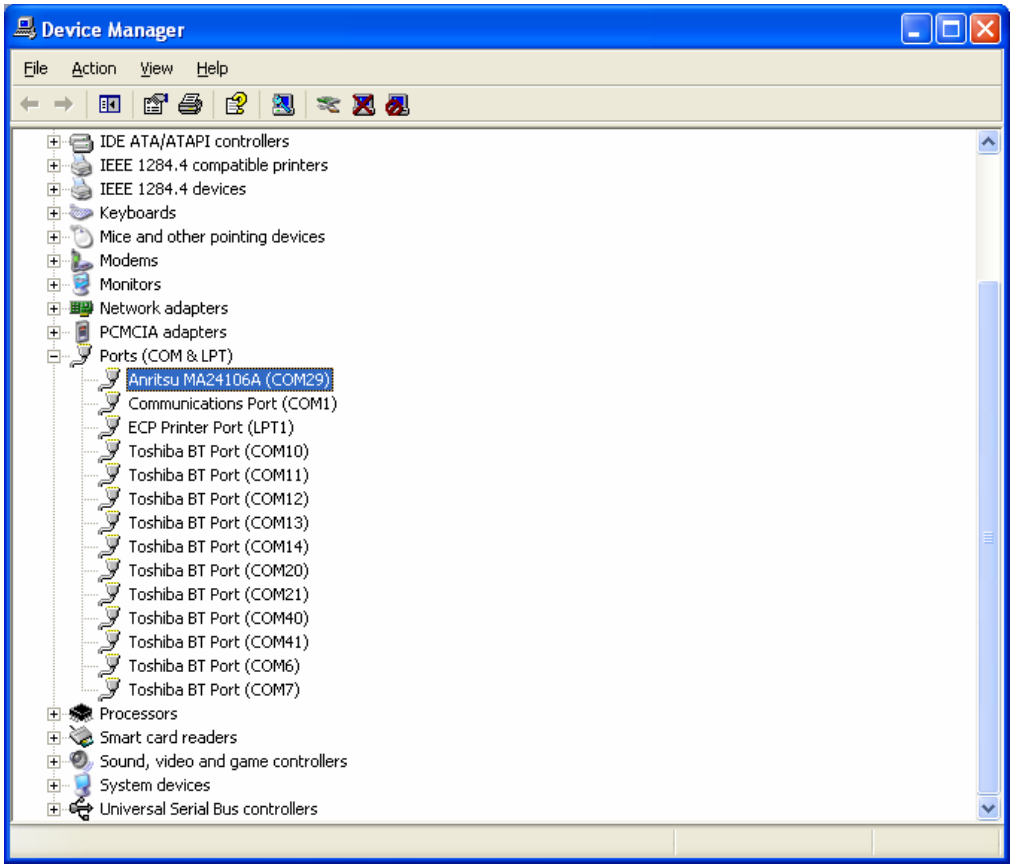


Figure C-3. Device Manager

4. Select the port that is assigned to the power sensor. Disconnect and reconnect the sensor and notice the new COM port number that appears. The new port is the current port assignment for the power sensor.

5. Right-click on the new port assigned in step 4 above and select **Properties** from the pop-up menu to display the properties for that port.

6. Click the **Port Settings** tab of the properties window.

7. Click the **Advanced** button to show the advanced property settings for the port.

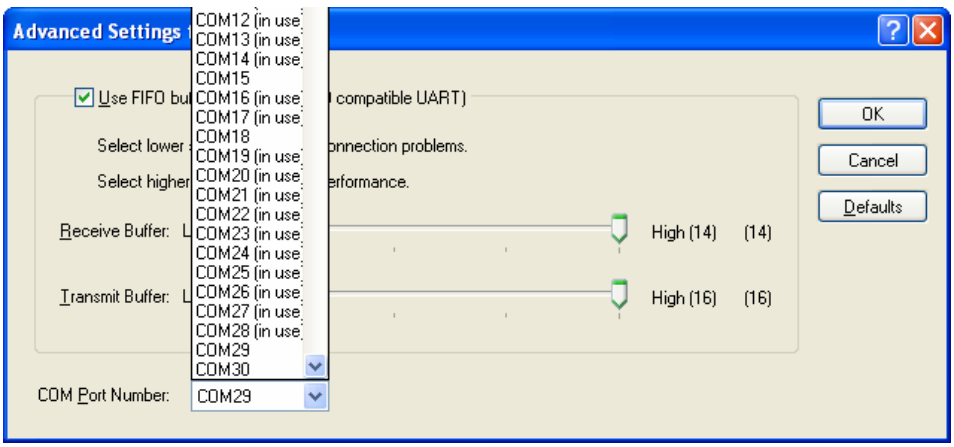


Figure C-4. Advanced Settings for COM Port

8. Select a COM Port Number in the range of 1 through 16. If possible, select a port which is NOT marked as "in use" in the COM Port Number list. If all of the ports are marked as being in use, select port number 16 unless you know for sure that something is actually using COM16.
9. You will get an alert when you close the window telling you that the COM port number may be in use by another device and asking if you want to continue. Click **Yes** to continue.

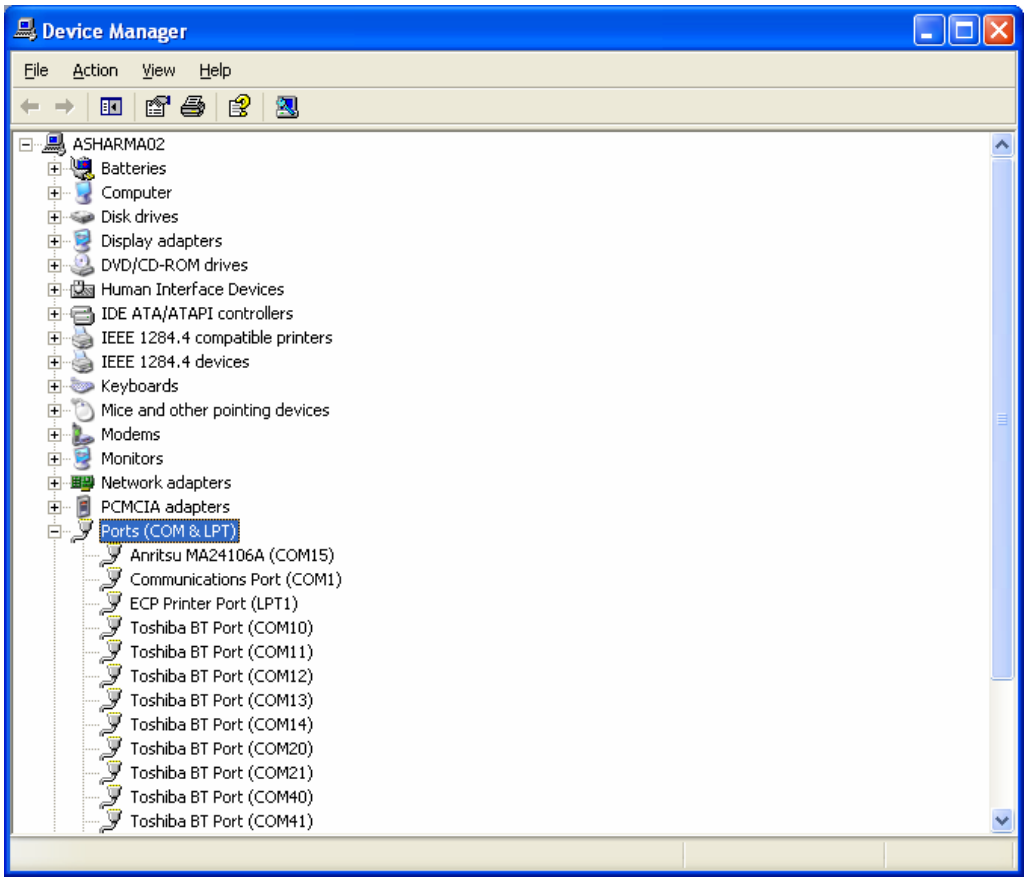


Figure C-5. Device Manager

10. Close all windows that you have opened up.

Index

A

adapter, cable 1-2
aperture time 3-11
  HAT 3-11
  LAT 3-11
  MA24108A, 118A, 126A 3-12
application demo A-1
ASDOFF 13-8
ASDON 13-8
auto shutdown 5-1
averaging
  MA24104A 5-6
  MA24105A 7-6
  MA24106A 9-6
  MA24108A, 118A, 126A 11-6
averaging table
  MA24104A 5-5
  MA24105A 7-5
  MA24106A 9-4
  MA24108A, 118A, 126A 11-4

B

battery, MA24104A 5-1

C

cable
  coaxial 1-2
  USB 1-2
calibrating the sensor
  MA24104A 5-4
  MA24105A 7-4
  MA24106A 9-3
  MA24108A, 118A, 126A 11-3
calibration factor correction
  MA24104A 5-4
  MA24105A 7-4
  MA24106A 9-3
  MA24108A, 118A, 126A 11-3
CD, installation 2-2
cleaning 4-7
coaxial cable 1-2
compatibility, of serial port C-1
connecting, DUT
  MA24104A 5-3
  MA24105A 7-4
  MA24106A 9-2
  MA24108A, 118A, 126A 11-2
connectors
  care 4-2
  cleaning 4-7
  disconnection 4-3
  of sensor MA241014A 5-1
  of sensor MA24105A 7-1
  of sensor MA24106A 9-1
  of sensor MA24108A, 118A, 126A 11-1
  teflon tuning washers 4-2
  visual inspection 4-4
contact Anritsu 1-4
contents, shipping 1-2
correction, calibration factor
  MA24104A 5-4
  MA24105A 7-4
  MA24106A 9-3
  MA24108A, 118A, 126A 11-3

D

demo application A-1
directivity uncertainty 7-8
driver, installation 2-1
DUT, connecting
  MA24104A 5-3
  MA24105A 7-4
  MA24106A 9-2
  MA24108A, 118A, 126A 11-2

E

error messages 11-11
error states
  MA24104A 5-10
  MA24105A 7-10
  MA24106A 9-9
  MA24108A, 118A, 126A 11-11

F

frequency response test
  MA24104A 6-6
  MA24105A 8-7
  MA24106A 10-4
  MA24108A, 118A, 126A 12-4

G

gauge, pin depth 4-6

H

HAT 13-7

I

inspection 4-4
installation 2-1
IPA 4-2, 4-7
isopropyl alcohol 4-7

L

LAT 13-8
linearity test
  MA24104A 6-8
  MA24105A 8-9
  MA24106A 10-6
  MA24108A, 118A, 126A 12-7
links
  contacting Anritsu 1-4
  product page 1-4

M

MA241xxA
  inspection 1-2
  installation 2-1
  product contents 1-2
  serial number 1-3
  settings 3-2
mapping serial port C-2
measurements
  MA24104A 5-1
  MA24105A 7-2
  MA24106A 9-1
  MA24108A, 118A, 126A 11-1
mismatch uncertainty 5-8
multitone signal measurements
  MA24104A 5-6
  MA24105A 7-6
  MA24106A 9-6
  MA24108A, 118A, 126A 11-5

N

negative pin depth 4-5
noise
  MA24104A 5-6
  MA24105A 7-6
  MA24106A 9-6
  MA24108A, 118A, 126A 11-6
number, serial 1-3

O

operational test
  MA24104A 6-1
  MA24105A 8-1
  MA24106A 10-1
  MA24108A, 118A, 126A 12-1
optimizing readings
  MA24104A 5-4
  MA24105A 7-4
  MA24106A 9-3
  MA24108A, 118A, 126A 11-3

P

part number
  coaxial cable 1-2
  software CD 1-2
  USB cable 1-2
pin depth
  negative pin depth 4-5
power measurement
  MA24104A 5-2
  MA24105A 7-2
  MA24106A 9-1
  MA24108A, 118A, 126A 11-1
power measurementMA24106A 9-1
power sensor
  cleaning 4-2, 4-7
power sensor precautions
  clean connectors 4-2
  ESD sensitivity 4-1
  excess power 4-1
  mechanical shock 4-1
  over-torque 4-1
  USB connector 4-2

R

remapping serial port C-2
required equipment, for test
  MA24104A 6-2
  MA24105A 8-2
  MA24106A 10-2
  MA24108A,118A, 126A 12-2
requirements
  hardware 2-1
  software 2-1
return loss, connectors 4-5
RF connector precautions
  alignment before connecting 4-2
  checking pin depth 4-2
  handle with care 4-2
  handling 4-2
  keeping connectors clean 4-2
  protective covers 4-2
  storage 4-2
  torque 4-2
RS232
  interface 5-1

S

Safety Symbols
  For Safety Safety-2
  In Manuals Safety-1
  On Equipment Safety-1
sample VB code A-1
sensor calibration
  MA24104A 5-4
  MA24105A 7-4
  MA24106A 9-3
  MA24108A, 118A, 126A 11-3
sensor zero failed 5-10

sensor zeroing
MA24104A 5-4
MA24105A 7-4
MA24106A 9-3
MA24108A, 118A, 126A 11-2
serial number 1-3
serial port C-1
configuration C-2
remapping C-2
settings 3-2
sensor 3-2
settling time
MA24104A 5-7
MA24105A 7-6
MA24106A 9-7
MA24108A, 118A, 126A 11-6
shipment 1-4
shipping contents 1-2
shutdown, auto 5-1
sleep function 5-1
software update C-2
storage 1-4

T

table, averaging
MA24104A 5-5
MA24105A 7-5
MA24106A 9-4
MA24108A, 118A, 126A 11-4
teflon tuning washers 4-2
temperature
out of range 5-10
test, frequency response
MA24104A 6-6
MA24105A 8-7
MA24106A 10-4
MA24108A, 118A, 126A 12-4
test, linearity
MA24104A 6-8
MA24105A 8-9
MA24106A 10-6
MA24108A, 118A, 126A 12-7
test, operational
MA24104A 6-1
MA24105A 8-1
MA24106A 10-1
MA24108A, 118A, 126A 12-1
test, VSWR
MA24104A 6-3
MA24105A 8-3
MA24106A 10-3
MA24108A, 118A, 126A 12-3
time, settling
MA24104A 5-7
MA24105A 7-6
MA24106A 9-7
MA24108A, 118A, 126A 11-6
tolerance, connector 4-6

U

uncertainty
measurement uncertainty 5-8
uncertainty components
directivity uncertainty (MA24105A) 7-8
mismatch 5-8
noise 5-8
temperature compensation 5-8
zero drift 5-8
zero set 5-8
uncertainty examples
MA24104A 5-9
MA24105A 7-9
MA24106A 9-8
MA24108A, 118A, 126A 11-9
uncertainty of a measurement
MA24104A 5-8
MA24105A 7-8
MA24106A 9-7
MA24108A, 118A, 126A 11-8
update software C-2
USB
serial port C-1
USB cable 1-2
user interface, layout 3-4

V

VB code A-1
visual inspection, connectors 4-4
VSWR test
MA24104A 6-3
MA24105A 8-3
MA24106A 10-3
MA24108A, 118A, 126A 12-3

W

web links
contacting Anritsu 1-4
product page 1-4

Z

zero
failed 5-10
invalid 5-10
range zero failure 11-11
zero drift 5-8
zero set 5-8
ZERO_ERROR 5-10

zeroing sensor
MA24104A 5-4
MA24105A 7-4
MA24106A 9-3
MA24108A, 118A, 126A 11-2

Alphabetical Index of Programming Commands

ASDOFF 13-8
ASDON 13-8
AUTOAVG 13-13
AUTOAVG? 13-13
AUTOAVGRES 13-14
AUTOAVGRES? 13-14
AUTOAVGSRC 13-13
AUTOAVGSRC? 13-14
AVGCNT 13-12
AVGCNT? 13-13
AVGRST 13-14
AVGTYP 13-12
AVGTYP? 13-12
CALDATE 13-4
CCDFTHRESH 13-16
CCDFTHRESH? 13-17
CHAPERT 13-19
CHAPERT? 13-19
CHMOD 13-18
CHMOD? 13-18
CHOLD 13-8
CHOLD? 13-9
CWDUTY 13-11
CWDUTY? 13-11
CWREL 13-11
CWREL? 13-12
DELETE 13-10
FORWARD 13-14
FORWARD? 13-15
FREQ 13-5
FREQ? 13-5
FULLBUF 13-11
GATEPARAMS 13-22
GATEPARAMS? 13-23
GATEVALUES? 13-23
GENABLE 13-23
GENABLE? 13-23
HAT 13-7
IDN? 13-4
LAT 13-8
MODTYPE 13-16
MODTYPE? 13-16
PWR? 13-5
PWRALL 13-5
RDBUF 13-10
RECALL 13-10
REVERSE 13-15
REVERSE? 13-15
RST 13-8
SAVE 13-9
SCOPEPARAMS 13-22
SCOPEPARAMS? 13-22
SETRNG 13-9
SETRNG? 13-9
START 13-4
STATUS? 13-7
STOP 13-4
TMP? 13-6
TRGARMTYP 13-29
TRGARMTYP? 13-30
TRGDLY 13-27
TRGDLY? 13-27
TRGEDG 13-26
TRGEDG? 13-26
TRGIMM 13-25
TRGLVL 13-26
TRGLVL? 13-26
TRGNOISE 13-28
TRGNOISE? 13-28
TRGSRC 13-25
TRGSRC? 13-25
TSLTPARAMS 13-20
TSLTPARAMS? 13-20
VIDEOBW 13-15
VIDEOBW? 13-16
ZERO 13-6

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